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THE VOLCANOES OF THE SANDWICH ISLANDS,

AND THEIR BEARING UPON VOLCANIC ACTION IN GENERAL.

By W. H. WESLEY.

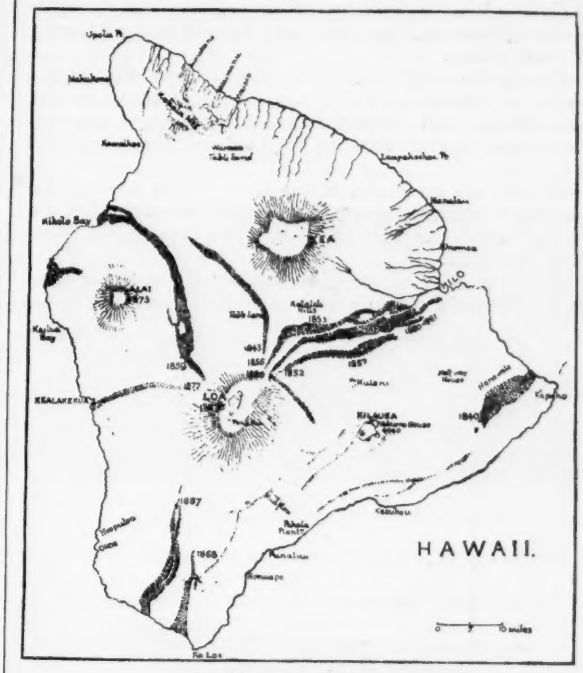
FOR many years after the discovery of Hawaii by Captain Cook in 1778 the visits of Europeans were few and far between, and the interior was long considered inaccessible. Our first accurate knowledge of the crater of Kilauea dates from the time of Mr. Ellis's visit in 1823. Since then we have, in the accounts of travellers and missionaries, sufficient material for a history of the Hawaiian volcanoes.

The eminent American geologist, Professor J. D. Dana, has lately published in the "American Journal of Science," vols. xxxiii.–xxxvi., a series of papers in which he has collected the accounts of all known eruptions of Mount Loa and of Kilauea. He has also compared their action with that of volcanoes in other parts of the world, and considered the light which they throw upon the difficult problems of volcanic action.

The loftiest mountain in Hawaii is the extinct volcano of Mount Kea, 13,805 feet; the highest active volcano (described by early travellers as also extinct) is Mount Loa, 13,675 feet. Kilauea is situated on the western slope of Mount Loa, at an altitude of 4,040 feet above the sea.

But little is known of changes which may have taken place in the crater, which is three miles long, on the summit of Mount Loa. Since 1832 all the known outflows of lava have begun at various distances below the summit. In 1834 Mr. D. Douglas, who was the first to ascend the mountain, looked into the interior of the crater from its rim, which he measured as more than 1,200 feet in height, and saw a desolate lava-covered plain 3½ square miles in area, with deep chasms from which hissing sounds proceeded, as though from some great internal fire. In 1841 the crater on the summit was surveyed by Captain Wilkes, who gave the height of the walls as from 784 to 470 feet.

In January 1843 one of the greatest eruptions commenced. Mr. Coan and Mr. Andrews saw a brilliant light at the summit, which lasted for a week, and about 700 feet



THE ISLAND OF HAWAII.

lower down a great discharge of lava flowed for more than six weeks, extending for a distance of over twenty miles. Mr. Coan found in the crusted surface of this stream many large steaming openings, down which he saw the lavas rushing along a tunnel-like way with awful speed some 50 feet below us. "Large stones thrown on the surface were carried instantly out of sight before sinking in the stream."

A great eruption occurred in 1852: the escaping lavas first rose in a lofty fountain, which was approached by Mr. Coan on its windward side within 200 feet; he found its height by angular measurement to be from 400 to 700 feet. The lava ascended continuously with "a roar like that of Niagara," says Mr. Kinney, another observer, who estimated the diameter of the opening from which the fountain flowed as about 1,000 feet. The lava stream in some places had a depth of 200 to 300 feet.

In 1855 Mr. Coan estimated the rate of the flow, as seen from the fissures in the crusted surface of the stream, to be forty miles an hour; this may possibly have been an overestimate. But the observation was made near the source, and at the front of the stream, where the lava had spread over a large surface and met with many obstructions, the rate was a mile a week. Owing to the cooling and the partial damming of the stream along the front, the hardened upper stratum was raised into numerous domes and tumuli, some as much as 100 feet high. Layer was added to layer, increasing the thickness from a few feet to 50 or 100. "After flowing freely for a time, the stream sometimes cooled and hardened along the front, remaining inactive for some days, till at length immense areas of the solidified lava some miles above the extremity were again in motion, cones were

uncapped, domes cracked, hills and ridges of scoria moved, and immense slabs of lava were raised vertically or tilted in every direction."

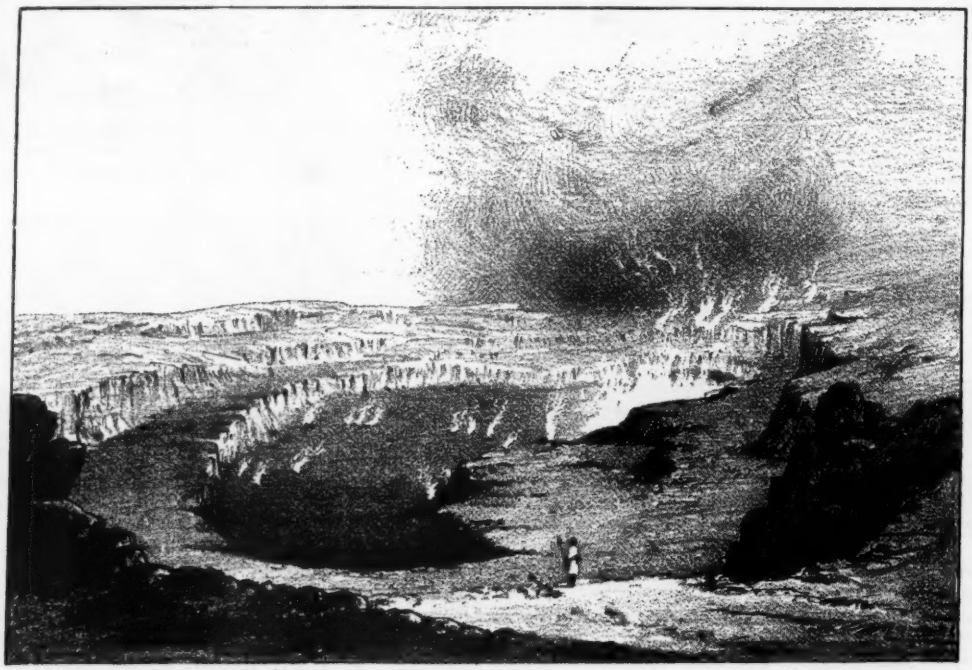
In 1859 there was another eruption; the lava stream reached the sea in eight days, running out on the shore at a red heat, having flowed for about thirty miles under the cover of its crusted surface. Loud explosions were heard all night long like the discharge of heavy cannon, and the light was so brilliant that fine print could be read at night thirty-five miles away.

During the eruption of 1868, the outburst was accompanied by violent and destructive earthquakes. At the great fissure from which the lava burst, large stones and rocks, some of about 100 tons weight, were thrown into the air.

In 1880 the movement of the front of the stream was unusually rapid, being sometimes as much as 75 feet an hour. Altogether there have been eight eruptions of Mount Loa since 1843.

From the great volcano of Mount Loa we must now turn to the wonderful volcanic plain of Kilauea, situated on its south-eastern slope. It is a depression of about $2\frac{3}{4}$ miles long by 2 miles wide, with nearly vertical sides, rising 300 to 450 feet above the level of the crater-plain. It appears to have been formed at a time of greater volcanic activity than at present, as the recorded eruptions have been confined to the lava lake of Halema'uma'u, about 430 feet in diameter, which lies in the great plain near its south-western extremity. Traditions gathered from the natives by the Rev. J. Dibble, nearly fifty years ago, record a great eruption about the year 1789, when the whole plain of Kilauea appears to have been in action, and stones, sand, and scoria were thrown to a great height, falling in a destructive shower for many miles round. The stones are found forming a deposit of 25 to 30 feet thick over an area extending ten miles or more from the crater. Many are of great size, and their solid character makes it probable that they were torn by the ascending lava from the deep-seated rocks along the conduit of the volcano. It appears to have been a *projectile* eruption, such as has not been known in more recent times.

In the sixty-three years from 1823 to 1886, there have been at least eight eruptions of Kilauea, four of them of great magnitude. They have been characterised by violent boiling of the lava in the lake, and the rising of numerous cones in and around it, ejecting steam, vapours, and fluid lava. The fountains of lava seldom exceed 50 feet in height, but there have sometimes been as many as fifty cones in various parts of the floor, and the furious action of the boiling sea of lava produces an indescribably impressive effect. The cones thrown up are often re-melted by the lava around them; one large one formed on the lava lake actually floated upon its surface, becoming stranded after the eruption of 1886 by the withdrawal of the lava from beneath. The eruption of 1886 lasted only a few hours; the volcano was observed to be unusually active in the evening of March 6, but by two or three o'clock in the morning the lava had entirely disappeared from the lake. During this short time, however, the pit had been filled to the brim, pouring into an adjoining lake that had been formed by a previous eruption, and melting the intervening bridge of lava. For several days after the eruption immense masses of the surrounding cliffs fell from a height of 200 feet into the lake with a sound like thunder. The lava appeared to make its escape through subterranean channels, as there was no visible outflow.



View of the Crater of Kilauea.

The most remarkable feature in the Kilauea crater is the frequent and extensive changes of level to which its floor is subject. A lower pit of great extent, which had sunk in a few hours to a depth of 400 feet in the floor, leaving a terrace round the whole crater, was raised again to its former level in $5\frac{1}{2}$ years. In 1840 the subsidence of solid

lava through the escape of liquid matter was unequalled: an area of 12,000 by 3,000 feet sank down nearly 400 feet. The floor rises and sinks in a remarkably level manner, and it is highly probable that it is supported by the column of liquid lava beneath. When a discharge has taken place the floor falls; then slowly rises to or above its former level, continuing to rise till another eruption occurs. There is scarcely any visible outflow of lava from Kilauea, in striking contrast with the immense discharge from Mount Loa.

Volcanic action in a crater where there are liquid lavas is to a great extent a kind of boiling process, and the confined vapours of the enlarging bubbles forcing an escape, are the chief projectile agencies through which the more terrific explosive phenomena are produced, as well as the milder ones of the Kilauea type. Increased activity means an augmented and more rapid escape of vapours through the viscid lavas, and also greater heat, and extension by fusion of the liquid lavas below the surface. The cinder cones made about the vents in quieter times may be destroyed or swallowed up by the great projectile eruptions when the force from the rising vapours becomes greater than the mountain can bear. Its sides then break, the liquid lavas pour from the fissures, and the top of the cone frequently sinks into the abyss.

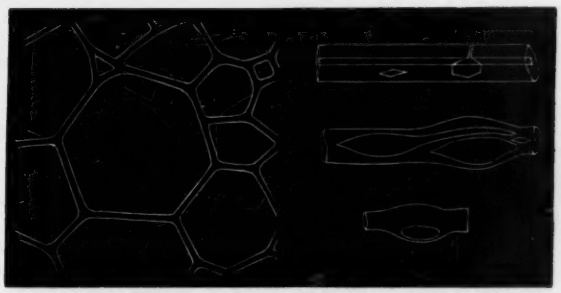
It is not our purpose to enter on the difficult question of the ultimate origin of the volcanic fires. It may be sufficient to mention the older theory of the original igneous fusion of the earth (still accepted by many geologists); and Mr. Mallet's hypothesis that the heat has been produced by lateral pressure, caused by shrinking of the earth's crust.* Whatever may be the cause of the heat, it is known that a mass at a high temperature may be kept solid by great pressure. When the pressure is relieved—either by slow denudation or by the opening of fissures—it will become liquid, and may rise to the surface. But this rise would be comparatively slow, and would certainly not cause eruptive phenomena, which it is almost certain are due to the agency of water, as was urged by G Poulett Scrope as far back as 1825.† The mode of its action has been recently discussed in an elaborate memoir by Professor J. Prestwich.‡

The slowness with which lava rises from deep-seated action alone is well shown in the case of Kilauea, where the epochs of high lava-level are separated by years. Three great eruptions in Kilauea were eight years apart, and in the interval the lift (as shown by the movement of the floor of the crater) was only 400 feet.

The sea is frequently assumed to be the source of the water of volcanoes, especially as they are commonly situated either in oceanic islands or near the seashore. We must remember, however, that this nearness to the ocean is probably in great part a result of the way in which rocks which undergo compression, so as to rise in island chains and ranges of mountains, are constantly developing new fractures parallel to their direction of upheaval. Professor Dana has pointed out that borings near the seashore generally yield fresh water, and that in Hawaii eruptions appear somewhat more frequent in the wet season. It seems probable that in this case the explosive force is caused by fresh water from the melting snows and very frequent rains, especially as the mountains are extremely cavernous and full of fissures. In the lavas of Vesuvius, however, there are salts which are probably of marine origin. The far greater eruptive force shown by Mount Loa than by Kilauea appears to result from the greater amount of snow upon the summit, as the characters of the lava are identical.

* "Roy. Soc. Phil. Trans.," vol. cxiii.
† "Considerations on Volcanoes," 1825.
‡ "Proc. Roy. Soc.," vol. xli.

In what manner does water act in producing eruptive discharges? In all probability by being introduced into the conduit of slowly rising lava. The probable processes are thus briefly summarised by Professor Dana: (1) Absorption of subterranean moisture from the sides of the conduit. (2) A rise of the lavas thus supplied. (3) After reaching a level where the pressure is sufficiently diminished, great vesiculation of the lava from the expansive force of the gases into which the water is resolved. (4) Further union of the gas particles into bubbles (where the vapours are sufficiently abundant) exerting the greater expansive force by which explosive results are produced. The great vesiculation which occurs is shown in the following figure of the lace-like scoria from Kilauea. The liquid lava when ejected is also drawn into capillary glass (called "Pele's hair" by the natives), which is often formed in great abundance.



Enlarged Figures of Scoria Cells and "Pele's Hair" The latter contain microscopic crystals and elongated air-bubbles.

On comparing these phenomena with those shown by other volcanoes there is found a great general similarity. The volcanic processes in Vesuvius, for instance, are in the main as in Kilauea: (1) filling; (2) discharging; (3) collapsing—alternating in its conditions between a volcano with a deep crater, and one with a top plain. The crater-pit of Vesuvius is sometimes 100 feet deep; this slowly fills by small injections within it of lava and cinders. This process generally goes on (with occasional outflows from fissures in the sides of the mountain) till the cavity is full, and a top plain of solidified lavas is formed, a mile or more in circuit, and nothing is left of its crater but the vent of a cinder cone. Smaller eruptions may form a large cone or cones till a grand outburst takes place; lava fragments are thrown upwards to great heights, and lava pours from opening fissures, till the great cone collapses and falls, as in 1806, and still more in 1822. In July, 1834, the summit of Vesuvius was a plain, with a small cinder cone, but at the great eruption in August of that year the plain had disappeared, leaving a deep crater. This took place again in 1839 and 1850.

The most striking difference between Vesuvius and the Hawaiian volcanoes is the immensely greater eruptive and projectile force in the former. The Tarawera eruption in New Zealand in 1886, and that of Krakatoa in 1883, are examples of eruptions of the more explosive kind. The destructive outbreak of Tarawera lasted only six hours, but its violence was so great that dust was ejected to a height of more than 44,000 feet, and an area more than fifty miles across was buried beneath volcanic mud. At Krakatoa the discharge was equally sudden and still more terrible and destructive. Dust was thrown to a height of probably 50,000 feet at least.

What is the cause of this great difference in eruptive force? Professor Dana considers that in Krakatoa and Tarawera the water must have gained access to the *interior*

of the lava conduit, causing the terrific boiler-like explosion. In New Zealand, the water was probably that of Lake Rotomahana, which was emptied during the eruption; in Krakatoa it was doubtless from the sea.

In general the difference between a comparatively gentle eruption like those in Hawaii and these more explosive outbursts is probably caused by: (1) The difference between the viscosity of the lavas. (2) The height and strength of the cone. (3) The greater or less abundance of the water supply.

The lavas of Hawaii are remarkably glassy and fluid; while those of Vesuvius are much more infusible and viscid. With regard to the second point it is evident that the strength of the mountain may be caused by its *form* or its *material*. Fissures open with comparative ease on Mount Loa, though its slope is much less steep than that of many volcanoes; its material is mainly basaltic, and to this its weakness is due. When a mountain is of great strength it is clear that much greater resistance is offered to the forces within, and when this is the case the eruption, when it does occur, will be more violent. With regard to the supply of water, it is probably far more scanty in Mount Loa than was the case at Krakatoa or Tarawera. In Vesuvius it is mainly the greater viscosity of the lava, causing greater resistance to the explosive force, that produces the violent projectile discharges from the summit. In Mount Loa the eruption frequently commences by activity in the summit crater, but this ceases when the pressure is relieved by the opening of fissures lower down.

The variety in the nature of volcanic products may evidently be caused by the different heights to which they are ejected, as well as by different rock material. At Kilauea, where the ejections seldom reach a greater height than 50 or 60 feet, the lava falls in a still fused state, while in volcanoes whose eruptions are more explosive it is cooled into scoria, pumice, or cinders. If the explosive force is very great, as at Krakatoa, the lava is blown into enormous bubbles, whose fragments are carried to immense heights. Where the water supply is very abundant mud is discharged, as at Tarawera.

It is remarkable that although Mount Loa and Kilauea are so near together, they appear to be quite independent, and there is no correspondence between their eruptions. Professor Dana considers that they support his conclusion, expressed many years ago, that volcanoes are no *safety-valves*, for, "if, while Kilauea is open on the flanks of Mount Loa, lavas still rise and are poured out at an elevation of 10,000 feet above it, Kilauea is no safety-valve, even for the area covered by the single mountain."

NITRATES.

By D. A. Louis, F.I.C., *formerly Assistant Chemist in the Rothamsted Laboratory of Sir John Lawes.*

A GOOD deal of public interest has recently been aroused with respect to the large deposits of nitrates found on the coast of Chili, and to their use in agriculture. The necessity for high farming in England and on the Continent, and the consequently large amount of produce taken off the land, calls nowadays for a correspondingly high return to the land of valuable constituents in the form of fertilisers, of which nitrates are perhaps the most important.

The class of substances known as nitrates are, chemically considered, compounds of nitric acid, which itself is a compound consisting of the three elements—hydrogen (H), oxygen (O), and nitrogen (N), combined in such proportions that every 100 pounds of nitric acid contains $1\frac{3}{5}$ pound of hydrogen, $22\frac{1}{5}$ pounds of nitrogen, and $76\frac{1}{5}$ pounds of oxygen. It is represented in chemical symbols by the formula HNO_3. When this acid comes in contact with a base such as a metallic oxide, the hydrogen and the metal change places, with the result that an oxide of hydrogen (water —H_2O) and a compound of the metal with the nitrogen and oxygen of the nitric acid are formed, the latter compound being a nitrate. Such a change may be represented in the following manner:—

Na_2O	+	$2HNO_3$	=	$2NaNO_3$	+	H_2O
Sodium oxide		Nitric acid		Sodium nitrate		Hydrogen oxide (water)

Nitrates are also formed by the action of nitric acid on many metals and on metallic carbonates.

Many nitrates are substances with which everybody is more or less familiar. Such, for instance, are:—Silver nitrate ($AgNO_3$), the lunar caustic used by surgeons; strontium nitrate ($Sr(NO_3)_2$), used in pyrotechnical displays for the production of red flame; potassium nitrate (KNO_3), known also as saltpetre and nitre, used in the manufacture of gunpowder, of which it constitutes 75 per cent.; there is also sodium nitrate ($NaNO_3$), or Chili saltpetre (otherwise known as cubic nitre, or nitrate of soda), the valuable constituent of the "nitrate" we hear so much about just now in connection with the western coast of South America, where there are enormous accumulations of it in the neighbourhoods of Tarapaca in Chili and Atacama in Peru.

Nitrates are frequently found in nature in other parts of the globe, more especially in India, but also in Arabia, Persia, Spain, and Hungary, and in small quantities they are present in almost all soils. They originate from decaying organic matter containing nitrogen; plants die, leaving their roots to rot in the ground whilst their stalks and leaves fall on the surface and suffer decay. Moreover, in all parts of the world, animal deposits of various sorts accumulate and suffer decomposition; whenever such decay takes place in the presence of air and of some base or bases in course of time the nitrogen of the vegetable or animal matter is converted into nitric acid, which forms nitrates with the base or bases; in some soils these changes take place with great rapidity. In various parts of Europe similar changes are produced artificially. Heaps are constructed of waste and decomposing vegetable and animal matter mixed with cinders, chalk, marl, &c., which are watered with animal liquors, and after a year or two large quantities of calcium nitrate are extracted from them.

Scientific investigations have shown conclusively that these important changes are the result of the vital activity of minute organisms whose appearance has, up to the present time, not been described by investigators so as to admit of their detection by the eye; either they are too small or too transparent to be seen with the microscope, or for some other reason they are not discernible. They, however, must exist in their myriads in the air, and are still more abundant in the upper layers of the soil. These little organisms have apparently their likes and dislikes, for they thrive vigorously in warm places, where there is sufficient moisture and plenty of bases, nutritious matter, air, and material to work on; on the other hand, they perish in the cold, and in the presence of many poisonous substances, such as corrosive sublimate, and they work badly in the light. But where conditions are favourable, or have been favourable to the existence of these little microbes, we find plenty of nitrates.

In those parts of India where the soil is light, and contains

a large proportion of chalky matter, and is rich in the remains of luxuriant vegetation, these nitrates are produced in abundance, and the soil near the surface is full of them. Frequently deposits of nitre are found in those places, looking like hoar frost on the surface of the ground. In Chili similar conditions have existed, and the deposits being near the coast, it is probable that they are largely derived from animal matter, most probably marine animals and birds; in fact, remains of ancient shells indicate that the sea was there in days gone by, although the deposits are now much above the sea-level. Even in England, where the climatic conditions are such that the little organisms cannot thrive so as to work with vigour all the year round, yet on a good arable soil the amount of organic nitrogen converted into nitric acid or nitrates during a year of fallow in a good season may be put down at near 100 pounds of nitrogen per acre, which is equivalent to about 600 pounds of Chili saltpetre.

In order to extract the nitrates the saltpetre-earth is soaked in water; the resulting liquid contains all the nitrates mixed with various other soluble constituents. In Chili this liquid is evaporated down; it then deposits an impure sodium nitrate mixed with varying, and frequently very large, percentages of sodium chloride (common salt) and sodium sulphate, and with smaller quantities of calcium and magnesium salts. This impure nitrate, known as crude nitre or "caliche," is refined by repeatedly redissolving in water and allowing it to crystallise, but a little common salt generally remains attached to the crystals of cubic nitre, so that the sodium nitrate of commerce as a rule retains about 2 per cent. of salt. In India and elsewhere two kinds of saltpetre-earth exist: 1. Earth rich in potash, which is treated in the manner just described, and yields impure potassium nitrate. 2. Earth containing only small quantities of potash, but much lime and magnesia; when this is treated with water the corresponding nitrates pass into solution, and the liquid is therefore mixed with crude potash (wood-ashes, containing a large proportion of potassium carbonate), or the earth is mixed with wood-ashes before being soaked in water. The resulting liquid then leaves on evaporation impure potassium nitrate. Impure potassium nitrate, crude saltpetre, or "grough," contains potassium and sodium chorides, sometimes in large quantities, and organic matter. It is refined very much in the same manner as the Chili saltpetre.

Pure potassium nitrate forms long six-sided clear crystals, which fuse readily, and, if not heated to a red heat, leave on cooling a white opaque fibrous mass known as sal prunella. Pure sodium nitrate forms crystals which look like cubes, hence it is sometimes called cubic nitre. Both nitres give up oxygen on heating to redness, and both, especially potassium nitrate, cause rapid combustion in contact with hot combustibles, and also with many metals. It is on account of its comparatively moderate activity in such combustion, and a tendency to absorb moisture from the air, that sodium nitrate is unfit for the manufacture of gunpowder, for which purpose such large quantities of potassium nitrate are utilised. Sodium nitrate is, however, employed in agriculture, for the preparation of potassium nitrate, for the production of nitric acid, and in the manufacture of sulphuric acid (oil of vitriol).

Its employment in agriculture is, without doubt, the most important industrial application of nitrate of soda. It is a well-known fact that plants, like animals, require considerable quantities of nitrogen for their proper development, and therefore, if plants are to develop well, the soil must contain this necessary constituent, not only in a form suitable for plants to assimilate, but also in sufficient quantities to supply their requirements. The following table shows what these requirements are for ordinary crops. In the first column is the name of the crop, in the second the average weight of the total crop at harvest, in the third the average amount of nitrogen contained in such a crop. The numbers are taken from Warington's "Chemistry of the Farm," and are per acre:—

Crop.	Weight of Total Crop at Harvest per Acre.	Nitrogen per Acre of Total Crop.
Wheat (30 bushels) and straw	4,958 lbs.	48 lbs.
Barley (40 bushels) and straw	4,527 „	48 „
Oats (45 bushels) and straw	4,725 „	55 „
Hay (1½ tons)	3,360 „	49 „
Red clover hay (2 tons)	4,480 „	102 „
Beans (30 bushels) and straw	4,160 „	99 „
Turnips (17 tons) and leaves	49,504 „	112 „
Swedes (14 tons) and leaves	36,064 „	102 „
Mangels (22 tons) and leaves	67,513 „	147 „
Potatoes (6 tons) and leaves	17,714 „	67 „

These numbers demonstrate what large quantities of nitrogen the various crops remove from the soil, whilst the following table, compiled from various papers by Sir John Lawes and Dr. Gilbert, referring to results obtained on the clay soil of the Rothamsted Farm, shows the effect of trying to grow crops with and without nitrogenous manure on a soil impoverished by the growth of previous crops, and consequently poor in nitrogen:—

Crops.	Grown on same Soil.	
	When poor in Nitrogen.	When Manured with Nitrogenous Manures and therefore rich in Nitrogen.
Wheat	2,090 lbs.	6,982 lbs.
Barley	2,454 „	6,443 „
Hay	2,535 „	6,993 „
Potatoes	4,452 „	17,192 „
Turnips	3,024 „	22,960 „
Mangels	11,312 „	69,104 „
Sugar-beet	14,448 „	80,528 „

The first table shows the requirements of various crops, the second illustrates the advantage derived by the employment of nitrogenous manures. Although, on most farms, much nitrogen is generally returned to the soil as farmyard manure, there is even then a large deficit which has to be made up by the application of artificial manures, and for this purpose many substances are sold; but, of all of them, nitrate of soda and ammonium salts are the best, for the simple reason that the others have generally to go through a preliminary period of change before all their nitrogen becomes available for plant nutriment, whereas the nitrogen of nitrate of soda is quite ready for the immediate use of the plant; and ammoniacal nitrogen, if not already available, very rapidly becomes so.

The results of numerous comparative experiments indicate that, on the whole, nitrate of soda is superior to the ammonium salts as a source of nitrogen for plants, but, excellent manure as it is, its use can become otherwise than beneficial if it be injudiciously applied.

Pure nitrate of soda contains in every 100 lbs. about 27 lbs. of sodium, 16½ lbs. of nitrogen, and 56½ lbs. of oxygen; but owing to the impurities the nitrate of soda of commerce has only about 15½ lbs. of nitrogen. The nitrogen is the active constituent, and the only one that needs to be taken into consideration when calculating quantities required as dressings for crops. Nitrate should be used only in such quantity as we know by experience is sufficient to supply enough nitrogen for a profitable increase of crop, any further addition being money

XUM

thrown away. It should not be used on light porous soils in districts where much rain is expected. It should as a rule only be applied where living plants already exist to make immediate use of the nitrogen; hence it forms an excellent material for top dressings in the spring. It is very soluble, and rain is required to make it sink into the ground and cause it to come in contact with the roots of the plants it is intended to nourish. On the other hand, too much rain would cause it to sink in the soil beyond the range of the roots, and hence become useless to the plants. This is the great cause of loss in connection with the use of nitrate of soda, and for this reason much more than the theoretical quantity of nitrate has to be employed for manuring crops. According to our first table, 100 lbs. of nitrate of soda ought to produce about 1,500 lbs. of wheat crop, but in practice only about 15 to 20 per cent. of the nitrogen applied in this manner is recovered in the crop. Therefore the resulting increase is correspondingly smaller, being nearer 250 lbs. than 1,500 lbs. Both grain and root crops are benefited by applications of nitrate of soda, and there is little doubt but the largest quantities will find their way to those countries where many acres of beet are grown for the production of sugar.

Plants dressed with nitrogenous manures always look much greener than plants grown without a good supply of nitrogen; intense greenness does not, however, necessarily indicate heavy or good crops—in fact, such a condition is more frequently the result of a deficiency of other plant foods in the soil; and although much chlorophyll accumulates, the plants, owing to imperfect nutrition, are not able to transform it into useful material such as starch and sugar; consequently such plants rarely mature properly. It must, therefore, be remembered that nitrogenous manures alone will not insure a good crop, unless all the mineral constituents required by the plants are also present in abundance in the soil; failing this condition the application of nitrogenous manure may be attended with loss instead of profit.

THE SHO-BANDAI-SAN ERUPTION.

THE eruption which destroyed the peak of Sho-Bandai-san in Japan on July 15 last is, next to the Krakatoa eruption, the most gigantic and disastrous volcanic disturbance of modern times. Sho-Bandai-san is, or rather was, one of a group of four conical mountains known collectively as Bandai-san, forming the walls of an old elevated crater basin, and rising to a height of some 6,000 feet above the sea-level. Stratified volcanic rocks, of the most part gneiss and andesite, constitute the greater portion of this mountain mass, and are mainly disposed in six great layers, the work of as many successive eruptions, the last of which took place, according to Japanese annals, 1,081 years ago. It had thus come to be regarded as an almost harmless, if not an extinct volcano, an idea that was, however, ruthlessly dispelled by the violent and destructive outbreak of July 15. On the morning of that day, after a slight preliminary earthquake shock, there came a shock of prolonged and fearful intensity. Then while the ground in the whole region was still heaving and groaning, and causing the houses to rock like ships at sea, a dense black column of débris, mud, and steam was shot forth from Sho-Bandai-san to a height of about 4,000 feet. During the next minute there were several repetitions of this phenomenon, all accompanied by loud explosions, and flashes of lightning, probably resulting from the electricity generated by the steam, shot forth from the ascending columns. In the meantime the lighter particles of the black columns, consisting of mingled steam and dust, reached an altitude of 12,000 or 15,000 feet above the summit of the mountain, and spread out into a vast flat cloud, which, until dispersed by the wind, enveloped the earth beneath it in the densest darkness. From this cloud descended a shower of volcanic dust granules, small masses, grayish in colour, which fell on the surrounding country in a scalding rain, causing dreadful injuries to people, and clothing the ground with a hot mantle on which it was painful and difficult to walk. This dust covered a land area of 1,040 square miles, and spread itself out in a fan shape, and at the Pacific shore, a distance of sixty-two miles, it had a breadth of forty-one miles. The noises of the explosions were of such intensity as to be plainly heard for a distance of sixty-two miles.

The amount of the ejecta may be judged from the fact that twenty-seven square miles of country were buried beneath volcanic débris, having over that area an average thickness of 57 feet. The matter distributed over the country by this eruption has been estimated to be equal in weight to 2,880 millions of tons. B. J. H

PENSION TO MRS. R. A. PROCTOR.

Readers of KNOWLEDGE will have heard with sincere pleasure that the Queen has been pleased to grant a civil list pension of 100*l.* a year to the widow of the late R. A. Proctor. Amongst the signatures to the Memorial to the First Lord of the Treasury recommending the grant were the names of—

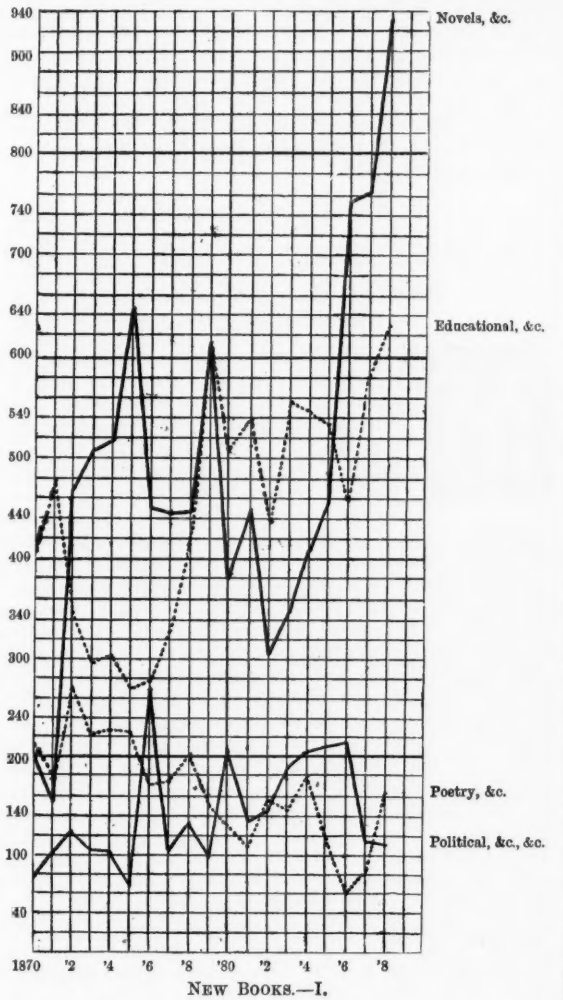
WM. HUGGINS (late President Royal Astro. Soc.).
JOHN TYNDALL.
T. W. HUXLEY (late President of the Royal Soc.).
W. MATTIEU WILLIAMS.
HERBERT SADLER.
G. L. TUPMAN, Col. R.A. (Secretary Royal Astro. Soc.).
WARREN DE LA RUE, F.R.S. (late President Royal Astro. Soc.).
WILLIAM LANT CARPENTER.
SIR HENRY ROSCOE (late President of the Brit. Assoc.).
C. J. LONGMAN (Messrs. Longmans & Co.).
GRANT ALLEN.
EDW. CLODD.
SIR JOHN LUBBOCK, Bart., M.P. (late President Brit. Assoc.)
CLEMENTS R. MARKHAM, C.B., F.R.S.
SPOTTISWOODE & Co.
SIR ROBERT BALL (Royal Astronomer, Ireland).
C. PIAZZI SMYTH (late Astronomer Royal, Scotland).
EVAN HARTNUP, Liverpool Observatory.
A. NORMAN TATE, F.S.C., F.C.S., F.G.S., &c.
KEGAN PAUL, TRENCH & Co.
J. HERSCHEL, Colonel R.E., D.C.L.
A. S. HERSCHEL (Prof. Durham Coll. of Science).
W. H. ALLEN & Co.
LORD GRIMTHORPE.
The EARL OF CRAWFORD (late President Royal Astro. Soc.).
RALPH COPELAND (Astronomer Royal for Scotland)
SIR F. L. MCCLINTOCK, Admiral.
ANDREW LANG.
The DUKE OF ARGYLL.
The MARQUIS OF LORNE.
The LORD ASHBURTON.
The DUKE OF NORTHUMBERLAND.
LORD BALFOUR OF BURLEIGH.
LORD MONCRIEFF.
JOHN INGLIS, Lord Justice General of Scotland.
A. RUTHERFORD CLARK, Judge, Court of Sessions, Scotland.
The LORD BISHOP OF LONDON.
The LORD BISHOP OF CHESTER.
R. BROCKLEBANK, D.L., Lancashire.
VERNEY LOVETT CAMERON, C.B., D.C.L.
LORD RANDOLPH CHURCHILL.
SIR RICHARD TEMPLE, Bart., M.P.
COLONEL E. B. MALLESON.
SIR O. T. BURNE
SIR GEO. BIRDWOOD.
ROBERT HAY MURRAY.
EDWIN CLARK.
COL. THOS. A. WETHERED.
C. S. MORDAUNT.
EVELYN HAY MURRAY.
J. F. CLERK.
CHATTO & WINDUS.
JOHN EVANS (Treasurer Royal Soc.).
SIR PENROSE G. JULYAN, K.C.M.G., C.B.
SIR W. HART DYKE, Bart., M.P.
R. RICHARDSON GARDNER, M.P.
HY. J. ATKINSON, M.P.
WM. FREDK. LAWRENCE, M.P., Liverpool.
ALFRED AUSTIN.
J. W. COMYNS CARR.
RICHARD MORRIS.
A. EGERTON LEIGH.
EDWARD G. MULLINS.
EDWARD STUBBS, Captain R.N.

ON CHANGES OF PUBLIC TASTE IN LITERATURE.

By Alex. B. MacDowall, M.A.

IT has been well remarked by an eminent living writer that the solidity and value of a person's life depend to a considerable extent on what he reads. On the other hand, a good deal may be learnt about a person from his choice of literature. A certain correspondence between what people read and what they are is often apparent in every-day life; and the literature of a nation at any given time is an instructive revelation of national tendencies.

How are we to characterise the literature that is being so profusely produced in this our time? What can we know of the various currents in this ocean of books—their origin, their force, their direction? Let us see how far the statistics

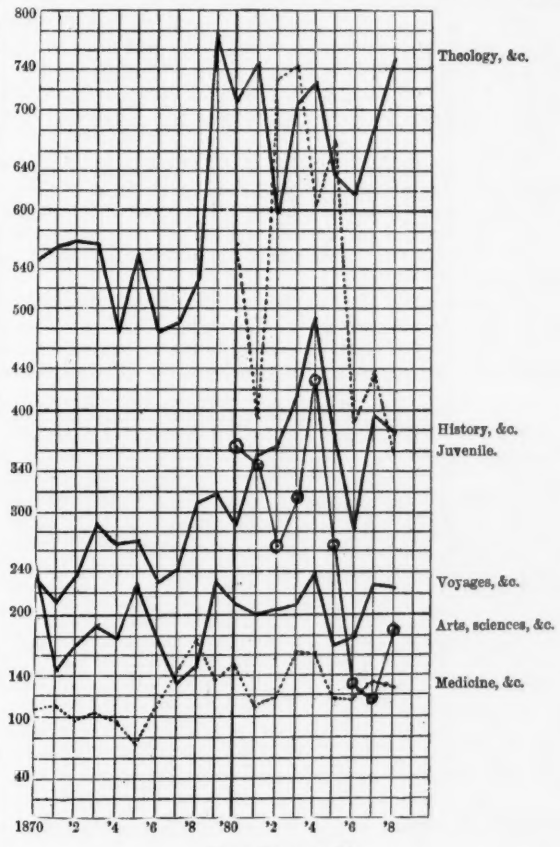


New Books.—I.

of new books published in the country during a series of years can help us towards an answer.

We take our figures from the *Publishers' Circular* since 1870, and put them into curves. These statistics are not, we suppose, absolutely exhaustive, but they probably include all books that can properly be said to be *published*. Classification of books is a very difficult matter (as anyone will tell us who has had to do with it), and some fault might perhaps be found with the system before us. But a uniform method has, we understand, been followed throughout those years. (Of the fourteen classes we give curves for ten only.)

The first thing that will probably strike one on looking at these curves, is the enormous and irregular growth of "Novels, Tales, and other Fiction" from 200 in 1870 to 929 last year. Thus we find that last year on an average about 2½ novels appeared daily! The curve of "Juvenile Works and Tales" (of which we give only a part in II.) seems to vary generally in an opposite sense, and as it must often be difficult to say whether a book should be classed as "juvenile," we might do well to see what a combination of the two classes would yield. We get thus a rapid and more regular growth of this kind of literature from 686 to 1,286, *i.e.* nearly 100 per cent. in eighteen years. These figures probably mean at once much unhealthy reading, and an immense amount of misdirected energy on the part of authors (as it cannot be doubted that the supply



New Books.—II.

is greatly in excess of the demand, large and growing though the demand is, owing perhaps to the growing tension of modern life). In no class so much as in fiction, we suppose, are so many books read that had better be left unread; and the second-hand bookstall is eloquent about three-volume novelists and their extinguished hopes!

The next place to fiction is taken by "Theology, Sermons, Biblical," &c., the number for last year being 748, and

200 above that for 1870. Note the sudden rise to 775 in 1879. The class "Educational, Classical, and Philological," yields a very similar kind of curve, reaching 630 last year.

We may next look at "Poetry and the Drama." The curve for this seems to tend, on the whole, distinctly downwards, though a marked rise appears in the last two years; from 272 in 1872 the numbers fell to 60 in 1886. These figures, of course, give quantity only, and tell us nothing of quality. But the influences of the age are somewhat adverse, it is to be feared, to the nurture of the finer forms of poetry; and the rare plant appears to be drooping at present. When Tennyson and Browning have left us, who are likely to fill their place?

Again, the generally upward course of the curve of "History and Biography" may be pointed out; the increase of late is probably much more in biographical than in historical works. The somewhat unsatisfactory class of "Arts, Sciences, and Illustrated Works," after some large fluctuations, was last year not far from its position in 1870. The curve of "Voyages, Travels, and Geographical Research" keeps much about a level; nor is there any pronounced tendency in the curves of "Political and Social Economy, Trade and Commerce," and of "Medicine, Surgery," &c.

Of the remaining classes (not shown in diagram) "Year Books and Serials in volumes" numbered 313 in 1870, and 324 in 1888; "Belles Lettres, Essays, Monographs," &c. 155 and 165; "Law, Jurisprudence," &c., 64 and 115; and "Miscellaneous, including Pamphlets not Sermons," 125 and 507.

Taking the total of new books, we find a fluctuating rise from 3,377 in 1870 to 4,960 last year, or about 48 per cent. The population increased, during this period, about 20 per cent. "New editions" (which we have not here considered) would increase the above totals by, roughly, one-third in each year.

The explanation of these fluctuations in the total, and in each class, is not very easy. The state of trade in general has probably something to do with them, but anomalies arise when we compare with a trade-curve. The great law

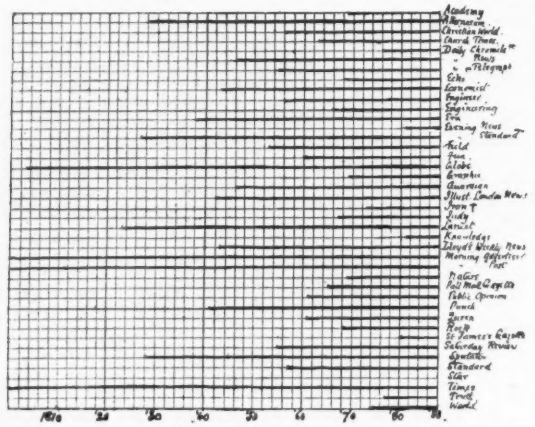


Diagram showing the Age of the Principal Papers and Periodicals.
The *Morning Post* dates from 1772; the *Times* from 1788; *Morning Advertiser*, 1794.

of rhythm may perhaps be discerned in book production; books of a given class are published in increasing numbers till the thing is found to be overdone, and there is a swing of the pendulum to the other side. Then there is the enormous growth of newspaper and periodical literature; and this, with its variations, must influence the annual crop of books.

As illustrating this remarkable growth, we add a diagram which shows, in a simple way, the ages of some forty well-known papers. It will be readily seen how young, on the whole, is this development; very few papers, indeed, reaching back to the earlier parts of the century.

NEWSPAPER STATISTICS.

From the "Newspaper Press Directory for 1889" we learn that "there are now published in the United Kingdom 2,176 newspapers, distributed as follows:—England:—London, 463; provinces, 1,277—total 1,740; Wales, 87; Scotland, 190; Ireland, 146; and Isles, 23. Of these there are 133 daily papers published in England, 6 in Wales, 19 in Scotland, 15 in Ireland, and 1 in British Isles. On reference to the first edition of the "Newspaper Press Directory" for the year 1846, we find that in that year there were published in the United Kingdom 551 journals; of these 14 were issued daily—viz., 12 in England and 2 in Ireland; but in 1889 there are now established and circulated 2,176 papers, of which no less than 174 are issued daily, showing that the press of the country has nearly quadrupled during the last forty-three years. The increase in daily papers has been still more remarkable—the daily issues standing as 174 against 14 in 1846. The magazines now in course of publication, including the quarterly reviews, number 1,593."

VARIABLE STARS IN NEBULÆ AND NEBULOUS VARIABLES.

By Herbert Sadler, F.R.A.S.

MR. PEEK'S observations of the variable S Coronæ having either been hid by nebulosity, or having apparently turned into a nebula, are very interesting and remarkable. In the case of this very star, Schmidt of Athens observed on one occasion that for several days before S became visible the place where it should have been seen appeared to be nebulous, and that then S became slowly recognisable. Tempel remarked the same nebulous glimmer about several variable stars, amongst them one of Goldschmidt's, which wholly disappears. One of the most remarkable instances is that of T Tauri. The nebula touching this star was found on the morning of October 11, 1852, in one of the finest skies ever experienced by Mr. Hind at Mr. Bishop's observatory in the Regent's Park, being at once caught in slow sweeping with the 7-inch refractor. A star of the 10th magnitude nearly touched the nebula on the *s.p.* side, and this star was subsequently found to be variable by Hind, being called T Tauri. In 1861 the nebula had completely vanished, though traces of it appear to have been seen by O. Struve at Pulkowa in 1862. But in 1863 and 1876 the nebula was looked for with the same telescopes and eye-piece with which it was first discovered, yet no trace of it was to be found. There appear to be several faint nebulæ about here, and the place should be carefully photographed. Dreyer could see no nebulosity round T with Lord Rosse's 6-foot reflector in 1877. The period of this variable star, T Tauri, touching the nebula, has, I believe, never been determined. Mr. Ingall informs me that with the 10-inch dialyte constructed by himself he saw on February 1 of the present year T Tauri very faint, about 14th magnitude, and faintly nebulous, and on February 6 he again saw a faint nebula

round the variable. This variable star, R Coronæ Australis, is also situated in a small nebula, and the nebula is variable also. Moreover, there is another variable star, S Coronæ Australis, and two other nebulæ within 5′ or 6′ of arc of this one. U Geminorum, a very remarkable variable, with an irregular period (it once increased three magnitudes in 24 hours), was observed by Baxendell to be nebulous at maximum. A star near Nova Vulpeculæ of 1670, within 1′ of arc of its calculated place, was observed to be nebulous or ill-defined by Hind, Talmage, and Baxendell. Of η Argus, Nova Cygni 1876, and Nova Andromedæ 1885, there is no need to speak. T Scorpii was situated apparently not in a nebula (for M 80 Scorpii, though often called a *nebula*, is really a very condensed cluster of small stars); but nevertheless, its probable association with the cluster, and the fact that there are at least two well-recognised and one or two suspected variable stars in the same field of view, is worthy of notice. The variability of at least a dozen small stars in or near the trapezium in the great nebula of Orion, and of certain parts of the nebula itself, is more than suspected, while Nos. 654, 709, and 822 of Bond's "Catalogue of Stars in the Nebula" are recognised variables.

THE TOTAL SOLAR ECLIPSE OF 1889, JANUARY 1.

By A. C. RANYARD.

A GREAT number of American astronomers, both amateur and professional, journeyed to the State of California to place themselves on the first of January of this year within the path swept out by the moon's total shadow. Within this narrow track of shadow during the minute that the total eclipse lasted observers were able to see the faint objects in the sun's neighbourhood which are usually hidden from our sight by the dust and small light-dispersing particles which float in the earth's atmosphere. Under ordinary circumstances this dust is so brightly illuminated by the sun's light that it blots out the stars and the faint light of the solar corona as if a veil were drawn across the heavens—a veil not thick enough to be opaque, but through which only brighter objects can be seen, the sun quite clearly, the midday moon subdued in light, and very occasionally a brilliant comet, and Venus at her brightest; but otherwise the blue veil of sky light with which everyone is so familiar blots out, or rather drowns with its own brightness, the fainter light of the stars and milky way, which shine behind it just as steadily as at night.

During the precious moments of totality the direct light of the sun, which ordinarily illuminates this blue curtain, is cut off by the body of the moon, and the dust-veil becomes transparent, so that for a few moments we can look through it and see the comparatively faint objects about the sun, which, one need hardly explain, can never be studied at night, as they rise and set with the sun.

During the darkest total eclipse a little light finds its way from objects on the horizon, outside the shadow area, to the dust floating in the air within the moon's shadow; and even this light is sufficient to faintly illuminate the dust-veil, so that it blots out most stars below the third magnitude, though sharp eyes have occasionally seen stars of the fourth magnitude when the observer knew just where to look for them; but we may be sure that it is only the brighter surroundings of the sun that become visible to our eyes during the darkest eclipse, or that leave their trace upon the photographic plates exposed during totality—nothing so faint as the milky way could possibly be seen.

On the opposite page, at the top left hand side, is a photographic reproduction from a paper copy of the corona kindly sent me by Mr. Burnham, of the Lick Observatory. Below is a photographic reproduction of a drawing by Miss Mabel Loomis Todd, kindly sent me by Professor Todd, of Amherst College Observatory, who is well known as an enthusiastic student of eclipse phenomena. At the top right hand side is a photograph from a sketch made from some glass positives of the same corona which have been sent to England.

The eclipse took place at a time when there were but few sun-spots, and the corona observed has the marked characteristics of a sun-spot minimum corona. The polar streamers curve away uniformly from either pole, and the equatorial extension is considerable. The equatorial groups of structure are bounded by rays which are greatly inclined to the radial line drawn from the sun's centre to the region of the limb from which they spring.

In comparing the lower drawing with the upper pictures of this corona, it should be remembered that Miss Todd's drawing has not been turned so as to bring the sun's axis vertical on the page with the north point uppermost. When this is done the correspondence between the drawing and the photographs can at once be traced. This drawing and the paper photograph here reproduced do not show the rays and brighter coronal structures visible on the glass photographs within the coronal area, but enough has already come to England to show that a very fine series of photographs showing a great deal of structure has been obtained during this eclipse. We look forward with much interest to the series of comparatively large coronal photographs taken with the large object-glass of Professor W. H. Pickering, who was stationed at Willow, California.

DRIFTING SAND.

By CECIL CARUS-WILSON, F.G.S.

IN walking along a sandy beach on a windy day we may see vast quantities of dry sand blown continually in one direction. In consequence of sand being blown thus in the direction of the prevailing wind, accumulations called *dunes* are formed, and these hillocks of drifted sand form interesting objects of study on various parts of our coast, as they are continually advancing, dispersing, or changing their forms.

On the north-western coast of Cornwall large sand drifts occur, and have overwhelmed an old Constantine chapel, the ruins of which may still be seen; some of these sand-hills reach a height of more than 300 feet. But our British sand-hills are insignificant when compared with the Hurku Hills in the Gobi Desert; these gigantic sand-drifts extend forty miles in length, and reach in some places an altitude of 900 feet, having been formed by the action of the wind upon the sand of the desert.

Sand dunes travel in the direction of the prevailing winds, and if precautions are not taken they continue to advance inland and overwhelm everything they encounter, even streams occasionally failing to arrest their progress. In Norfolk buildings have been buried, in Scotland vast tracts of fertile land have been turned into barren wastes, and in Ireland the ancient town of Bannow has disappeared beneath the advancing sand-drift.

Some years ago, on the coast of Crozon, near Brest, a large hill of sand was removed by a gale, and the remains of a village with a church and churchyard exposed to view;

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how long this village had been buried no one knew, as no records could anywhere be found to throw light upon the subject. The existence of buried cities beneath the sands of Egypt is well known, parts of the higher buildings rising like monuments above the desert to mark the tombs beneath.

On the shores of the Bay of Biscay the drifting sand travels inland at a rate of about 16 feet in a year, while in some parts of Denmark the rate of encroachment reaches 24 feet in the same time. A survey made some years ago in Southern India showed that the movement of sand hills with the prevailing wind reached the high average of 17 yards per annum.

The advance of drifting sand may sometimes be checked by planting the dunes with the cluster pine, sand marram, &c.; these form a network of rootlets binding the sand together, which, with their protective covering of vegetation, prevents further drifting. Sir Wyville Thomson gives a graphic account of the celebrated "sand glacier" at Elbow Bay, in the Bermudas; it is a dune of pure white coral sand, which has filled a valley, and is slowly advancing inland in a mass 25 feet thick; it threatens to overwhelm cottages and woods, and could only be arrested by the planting of the native juniper and oleander. Many instances occur in the Bermudas of houses and woods being buried beneath these coral sand dunes.

Occasionally, blown sand is mixed with fragments of shells or other calcareous particles. Rain-water holding carbonic acid in solution may then dissolve these fragments, and rearrange the lime as a cement, and this binds the grains together and forms a friable sandstone. Near Newquay, in Cornwall, sandstone of this recent *subaerial* formation occurs in cliffs of considerable height, and the hardest varieties have been used in the construction of Cranstock Church and many other buildings in the neighbourhood. The curious cylinders of indurated sand—"Pixie Holes"—occurring at Little Fistral, in the same neighbourhood, are the result of similar consolidation; the sand was compacted into a solid mass by means of the calcareous cement, and part of this was again subsequently removed by percolating water.

In the island of Bermudas—which is simply a large bank of drifted coral sand—the only rock occurring is "a white granular limestone" formed by the same chemical process.

On the coast of Gascony, where sand dunes extend for over a hundred miles, more elaborate means had to be adopted in order to save the land from being buried beneath the drifting sand. A wooden palisade was erected along the shore, and as the sand drifting against it accumulated and increased in height, the palisade was continually raised until it reached an altitude sufficient to bar the progress of the sand.

Drifting sand may be carried to a great height by a strong wind. In our country, during gales, when the sand is dry it may be carried up 200 feet or more; but in the sand-storms of the deserts, when "sand-spouts" occur, it probably reaches a much greater height than this. In the spring of 1882 a remarkable sand-storm raged in Iceland for two weeks. The air was so filled with grains of fine sand that it was impossible to see objects a few yards off, and though the sky was clear of clouds the sun was rarely seen. Like the fine volcanic dust that overwhelmed Pompeii, this sand penetrated through the smallest cracks and crevices, entering the houses, and becoming mixed up with the food. Thousands of sheep and horses died owing to the sand being drawn into their lungs at every inspiration.

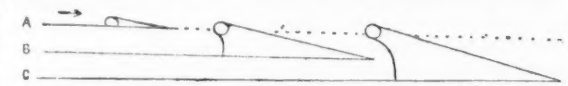
At the late Bath meeting of the British Association, in an interesting communication by General Strachey on the "Sea Temperature in the neighbourhood of Cape Guardafui," it was shown that this cape, the most eastern point of Africa, was, owing to the large and continued increase in the number of ships frequenting the canal route, one of the most important headlands in the world. Homeward-bound vessels from the East by the canal make for Guardafui, just as ships bound for the English Channel steer for the Lizard. During the period of the south-west monsoon, and especially from June to August, the vicinity of Cape Guardafui is enshrouded in a dense haze, extending far out to sea. Now, this haze is due to the suspension in the air of great quantities of fine sand, which have been brought by the wind from the African deserts. Vessels thus have great difficulty in making the land, many are frequently lost, and the navigation of the coast is fraught with much danger through the action of wind-borne sand.

Wherever drifting sand is continually blown against hard rock it polishes the surface by its constant friction. The hard granite cliffs on the Cornish coast are polished and furrowed in this way, and the Egyptian monuments, where exposed to the sand-laden winds of the Libyan desert, present a similar polished appearance.

At the Edinburgh meeting of the British Association in 1871, Mr. Grieve described some large masses of limestone occurring on the shore near Burntisland which were polished by drifting sand, and through the means of which he discovered a new species of a coal measure fossil plant—*Dictyoxylon Grievi*—occurring in the limestone.

Many of the desert pebbles are beautifully polished, having a remarkable and characteristic varnished appearance, owing to the action of drifting sand, and the scooping out of the dry *wadys* of Palestine has been effected by the same means.

In connection with this, Mr. Blake has described the action of drifting sand in the Pass of San Bernardino, California. He says that the surface of the granite forming the projecting spurs of the mountain of San Gorgonio was beautifully grooved and polished, and long and parallel furrows were cut out by the abrading action of drifting sand. The hardest minerals present in the granite—quartz, tourmaline, and garnets—were all cut down and left with polished surfaces. An interesting fact was that some of the garnets, being harder and less easily worn than the other minerals, were left standing in relief upon long pedicles of felspar that had been more quickly worn away. On the lee side of some of these garnets the felspar was protected from the advancing sand, so that it frequently stood out in ridges to the leeward of the gems. It was easy thus to see which was the direction of the prevailing wind, and Mr. Blake says: "These little needles of felspar, tipped with garnets, stood out from the body of the rock in horizontal lines, pointing like jewelled fingers in the direction of the prevailing wind."



PILLARS OF SAND SUPPORTING PEBBLES OR SHELLS.

I have often observed a similar phenomenon in walking along the sands between Bournemouth and Poole Harbour; dry sand is frequently blown rapidly along the surface of the beach left wet by the retreating tide, the wet sand being usually crowded with pebbles or shells. On the higher part of the beach, where the sand is blown violently against these pebbles, &c., they resist the advancing sand and protect that on the lee side of them; the wet sand, too, behind the pebbles, owing to the protection it receives, is not dried so quickly as the surrounding sand, and the result of this action is that the pebbles and shells are left standing on

remarkable little pillars of wet sand, which increase in height as the more rapidly dried sand is blown away. The drifting sand and wind together eat out the bases of these little pillars, causing them to point in the direction of the wind; as these increase in length the weight of the suspended particles overcomes the cohesion of the wet sand, and they fall to the ground. These pillars vary from one to two or three inches in height, according to the size of the capping stone or shell. Reference to the accompanying diagram will show three stages in the growth of these pillars.

The abrading action of sand when conveyed by a current of air has been taken advantage of in the construction of the "sand-blast," in which sand is carried up a pipe terminating in a nozzle from which a jet issues with great force, and eats away any hard substance with which it comes in contact. Glass is by this means engraved, especially gas-globes, the "frosted" appearance of which is due to the impinging sand; that part of any glass article which is to remain untouched is coated with some soft, elastic substance such as glue or gelatine; into this the driven sand becomes embedded, and, consequently, has no effect on the glass. Only hard substances are abraded; the workmen can hold their hands in the jet of sand with impunity, but the nails of the fingers would very quickly be destroyed if exposed to the blast. Files are by this means cleaned of the softer metals embedded between their teeth.

The sand-blast is now brought to such a state of perfection that even the pattern of a delicate lace can be reproduced on glass, while the power of the blast is such that wood, marble, granite, and even steel can be perforated in a few minutes.

NORTH AMERICAN-INDIAN FAIRY-LORE.

By Miss Mary Proctor (Stella Occidens).

"IT is well known by all Indians who still keep the faith of the olden time that there are wondrous dwellers in the lonely woods, called by the Micmacs *Mikumwessos*." They were created from the bark of an ash tree by the great Algonquin god, Glooskap, a hero who is somewhat like the Scandinavian gods Thor and Odin. His name means "the liar," because when he left the earth, like King Arthur, for Fairyland, he promised to return, and has not as yet kept his promise.

Before man was, he created the Mikumwess, or small elves, dwellers in rocks. They are fond of playing on magic flutes, and a maiden who hears the melody is bewitched with love, and if the fairies are sufficiently pleased with her, they make her a fairy like themselves. They play all day long in the woods, among the sunlight and shadows. One day when Glooskap was walking through a forest he suddenly came upon a group of these dancing elves. Their queen, Summer, was so beautiful that Glooskap caught hold of her and ran away with her in his arms as fast as he could. The fairies threw a rope after him, which coiled itself around his neck; but as he ran it unrolled, and he was soon out of sight. He took Summer to the lodge of Winter, and presently Winter melted away, and his wigwam too. "Then everything awoke; the grass grew, the fairies came out, and the snow ran down the mountain-side into the rivers, carrying away the dead autumn leaves. Then Glooskap left Summer with them and went home."*

On another occasion some of the fairies were invited to a wedding, and one of them astonished the people very much by his dancing. "As he danced around the circle upon the hard beaten floor, they saw his feet sink deeper at every step, ploughing the ground up as the dance went on, into a trench, until at length only his head was to be seen." This ended the dancing for that evening, for the ground could only be danced on after that by fairies and witches.

Sometimes mortals have married fairies, and lived with them in their forest home. If a man sees a fairy, he has but to tap her lightly on the head with a small stick, and, according to the laws of Fairyland, this makes her his wife. The custom, on being captured, is for the maiden to faint away; then she is carried off quietly to her new home. Apparently she has not much choice in the matter.

In the olden times there were two hunters, who lived by themselves in a lonely forest. When winter-time came, and their snow-shoes and mocassins gave out, they wished that a woman was there to mend them. Now, by means of sorcery a bright little fairy knew their wish, and one evening, on their return from the woods, the younger brother found the wigwam cleaned and swept, a fire built, and the pot boiling for supper. The hunter did not tell his brother, and took all the credit to himself. The same thing took place next day, and the day after; the hunter watched the door from a hidden place. Presently a beautiful and graceful girl entered the wigwam, and was soon busy with the housework. The hunter walked into the hut, and the girl was at first alarmed when she saw him, but he calmed her, and they were soon the best of friends. When all the work was done, they played together, like two children, in the sunlight and shadows of the forest, for they were both young. When the sun's shadows became long, the girl said, "I must go now, I hear your brother coming, and I fear him. But I will return to-morrow. Adieu." This continued for many days, and when at last the younger brother told the older brother, he said, "Truly I should be glad to have some one here to take care of the wigwam and mend our snow-shoes." So the winter passed away very pleasantly, until summer came and melted the snow, and it was time for the hunters to return to their village.

As they approached their home the fairy left them, for she knew by sorcery that their father would not be pleased to see her. Indeed, when he heard about her, he was very angry, and said, "All my life have I feared this. Know that this woman was an imp of the woods, a witch of the Mitche-hant, a sister of the *Oonahgamess*." Then these ungrateful brothers were afraid, and went forth to slay her, and the elder brother shot an arrow at her. "Then there was a strange fluttering of scattered feathers, and they saw her fly away as a partridge." When they told their father, he said, "You did well. I know all about these female imps who seek to destroy men." Now the younger brother longed to see the fairy again. He found her in the woods, and they were soon friends again, and played together as before. And when evening came the boy said, "I must return."

"Whenever you would see me," the maiden replied, "come to the woods. And remember what I say. Do not marry any one else, for your father wishes you to do so, and he will speak of it to you, and that soon. Yet it is for your sake only that I tell you this." She told him that, if he married another, he would surely die. And all came to pass, for the father compelled his son to marry a bride from a distant land. The bride came, and for four days they feasted and held a wedding dance. But on the evening of the fourth day the bridegroom said, "This is the end of it all," and he laid him down on a white bearskin and died. Then the father left the place for ever, and wandered far away brokenhearted.

* Charles Leland, "Algonquin Legends," p. 134.

Among the Indian traditions there is one bearing a resemblance to the story of "Bluebeard." A hunter had taken under his care an elf, who was so small that he always kept him in a box. When the hunter left home he would close the lid carefully, so that the evil spirit (Mitche-hant) should not get hold of him. One day this hunter saw a very beautiful girl sitting on a rock by the river-side, so he paddled his canoe quietly towards her. However, she saw him coming, and in a moment she disappeared under the waves. Her mother, who lived among the mermaids, advised her to return to the hunter, who would treat her well if she obeyed his commands. The maiden did not find the hunter at home, but she cooked supper for him, and put his wigwam in order. The hunter was very pleased to find her on his return after a long day's hunt, and bade her cook half a beaver he had brought home. The same command was given every day, until the hunter's wife began to wonder how the other half of the beavers disappeared. She determined to watch her husband, and one night she pretended to be fast asleep, whilst she was really as wide awake as she could be. Then she saw her husband cook the other half of the beaver, and, opening a box which stood in a corner of the room, he took out the little red dwarf and fed him. He also washed him and combed his hair, and put him back in the box again. Next morning when the hunter had gone out, his wife opened the box and tried to coax the little elf out. Finally she pretended to go away, and the dwarf peeped over the top of the box to see where she had gone, when she caught hold of him, and held him tightly. But her fingers on touching him were stained red, and as she tried to comb his hair, they became redder still. To add to her terror, a fearful clap of thunder rent the air, the door flew open, and a most horrible looking being entered the room. He snatched the little man out of her hands, and vanished in a flash of lightning. However, the unhappy girl had no time to waste, for she knew her husband would wonder at the red stain on her hands, and she must wash it off before he came home. But the more she washed the brighter it became, so she resigned herself to her fate. When her husband saw her terrified face and red hands, he knew what she had done. He seized his bow to beat her, but she ran out of the wigwam, and threw herself into the river, and as she touched the water she turned into a sheldrake duck, and to this day the marks of the red stain are to be seen on her feet and feathers.

THE GREAT NEBULA IN ANDROMEDA.

N the opposite page is a reproduction by a new process from a paper photograph enlarged about four diameters from Mr. Isaac Roberts's negative of the Andromeda Nebula taken on December 29, 1888, with an exposure of four hours. Considering the great interest attaching to this photograph, it has been thought advisable to give this reproduction by a photographic process to compare with and check the woodcut given in our last number. In order to prepare the woodcut in time for the February number, it was necessary to engrave it on a wood block which took to pieces, and could be given to two different engravers to work upon at the same time. Unfortunately the block was not put together again with sufficient care, and a white line corresponding to the division between the two parts of the block shows across a part of the middle of the page, which corresponds to nothing on the photograph. Some white dots have also been put in by the engraver to increase the brightness of the southern end of the nebula, which have come out as small stars on the woodcut, and have no existence upon the photograph. But otherwise the woodcut gives a very satisfactory representation of the original negative, except that it was impossible to show the structure in the brighter central part of the nebula, which has a stellar nucleus, and the faintest regions of nebular light. The same difficulty has to be contended with in the photographic reproduction now given, and in addition the smaller stars shown in the original negative are lost.

The illustrations of the Lick Observatory, published in the December number of Knowledge, were made by a photographic method from the excellent woodcuts of the Observatory published in *Engineering* for August 31, 1888. This and the subsequent numbers of *Engineering* contain plans to scale of the dome, with the hydraulic machinery for raising the floor, and other ingenious contrivances of Sir Howard Grubb and others, made use of in the Lick Observatory.

Letters.

[The Editor does not hold himself responsible for the opinions or statements of correspondents.]

VIVISECTION.

To the Editor of Knowledge.

Sir,—The inexplicable fascination supposed to be exercised by snakes over little birds seems to be exercised by Snake-poison Experiments over physiologists. Again and again warnings have been issued by eminent men of science of the utter inutility of trying to run after and overtake the venom coursing through the veins of a bitten man and then neutralising it by means of an antidote which, even if discovered, could scarcely be expected to form a Pocket Companion for the 20,000 nearly naked Hindoos who are alleged to perish annually from Snake-poison in the jungle. Such cautions are all in vain. "Hope springs eternal" in the physiological breast. Science never has, but always will, be blessed by the discovery of the grand Arcanum.

Permit me to quote the observations of Sir Joseph Fayrer, himself a vivisector and a great authority on snakes, in his presidential address before the Medical Society of London, as reported in the *British Medical Journal*. After referring to the supposed virtues of permanganate of potash, Sir Joseph said :—

> We are still, then, as far off an antidote as possible, and the remarks made by me in 1868 are as applicable now as they were then. They were as follows: To conceive of an antidote, as that term is usually understood, we must imagine a substance so subtle as to follow, overtake, and neutralise the venom in the blood; and that shall have the power of counteracting or neutralising the poisonous or deadly influence it has exerted on the vital force. Such a substance has still to be found, nor does our experience of drugs give hopeful anticipations that we shall find it.—*Brit. Med. Journal*, Feb. 2, 1884.

Dr. Lacerda, in a letter to Sir Joseph, wrote to the same purpose: "As to the idea of finding a physiological antidote for snake-poison, I entirely agree with you that *it is a Utopia*"—a remark the sense of which is plain, though the grammar is open to discussion.

Mr. A. J. Field, in his article in your issue of February 1, shows that in time the sanguine (I will not add sanguinary) spirit of modern biology overleaps such obstacles as those described by Fayrer and Lacerda. He flies straight to "Utopia" *vid* Boulogne; happy to carry forward his researches in that "beautiful France" where

THE NEBULA IN ANDROMEDA.

From a Photographic Enlargement by MR. ISAAC ROBERTS, *of his Negative of 30th December*, 1888.

(as M. Zola would lead us to suppose) every other kind of licence prevails, but where no licence is needed for vivisection. Your readers will reflect with satisfaction that Boulogne boasts brighter attractions than that of freedom to torment animals; else they would feel that the crossing of those stormy waters of the Channel from Folkestone merely for the sake of such experiments as are described by Mr. Field in your columns, was altogether a Quixotic undertaking on the part of that knight-errant of science.

I have very little to say of Mr. Field's experiments. They were by no means specially cruel, and he expresses an amount of compassion for his little white-mouse victims, which is quite a novel feature in the reports by physiologists of their own doings. Like Walton's angler, he treats the worm he puts on the hook "an' as if he loved it." But I think that the repetition of these everlasting tricks with snakes and poisoned animals, which form the "Chamber-sport" of so many men of science, is a moral phenomenon not undeserving of notice among the morbid vagaries of the human mind. Mr. Field mentions Fontana's experiments, and I have no doubt he has seen the edition of his great work on the "Venom of the Viper," published just a century ago (1787) by the John Murray of that day, wherein the translator (a surgeon named Skinner) challenges our confidence on behalf of his author in this portentous sentence:—

> But what confidence ought not an author to inspire us with, who, after having said, "I have made more than 6,000 experiments; I have had more than 4,000 animals bit; I have employed upwards of 3,000 vipers," finds no difficulty in adding, "*I may have been mistaken, and it is almost impossible that I have not been mistaken.*"

Unless Mr. Field can flatter himself that he can greatly overpass Fontana's forty hecatombs of unhappy animals killed in this painful way, I do not see how he can flatter himself with any hopes that he also will not be "mistaken" in any discovery he may imagine himself to make. Truly Dr. Leffingwell wrote well on this whole subject of vivisectional experimentation when he said: "If animal pain could be measured by money, there is no Mining Company in the world which would sanction *prospecting in such barren regions.*"

Mr. Field thinks that "he who hinders the progress of such investigations commits a sin against mankind." I venture to assert, on the other hand, that he who, for the sake of remote and doubtful physical benefits to our race, encourages a practice which, unquestionably and immediately, must stifle the divine impulses of compassion and pity in the human soul, is the real "sinner against mankind." I have even some support for the further belief (though I attach much less importance to it) that he who opposes experimentations on animals is also a truer friend to Science than he who promotes them. Mr. Lawson Tait, one of the first surgeons of the day, concludes his powerful paper on the "Uselessness of Vivisection" by these noteworthy words:—"I hope I have made it clear that, deeply as I feel the strength of the objection to the practice of vivisection upon the various grounds indicated at the beginning of this paper, I urge against it a stronger argument—that it has proved useless and misleading, and that in the interests of true science its employment should be stopped, so that the energy and skill of scientific investigators should be directed into better and safer channels."—I am, Sir, truly yours, FRANCES POWER COBBE.

Hengwrt, Dolgelly: February 7.

To the Editor of KNOWLEDGE.

I have to thank the editor for giving me an opportunity of replying to Miss Cobbe's criticism on my paper in the last number. She quotes Sir Joseph Fayrer and Dr. Lacerda as if they thought it useless to experiment further, and had been converted from the errors of their ways; but neither of these vivisectors has given up vivisecting and experimenting, as we must conclude that they would have done if Miss Cobbe's interpretation of their words were correct.

The fact that an antidote has been discovered which is capable of "coursing after and neutralising" the poison of many viperine snakes renders it probable that a similar antidote may be discovered for the poison of the colubrine snakes and all the other venomous creatures which occasionally endanger the life of man.

Miss Cobbe is too impatient if she expects such discoveries to be made on the first or second experiment; our steps to higher knowledge are made very slowly—generally after repeated failures. She forgets the long series of painful deaths which have brought about each step in the survival of the fittest, and that Nature herself is far more cruel than any man of science. What student of nature is guilty of such cruelty as the Ichneumon fly, whose eggs are deposited within the body of the living victim so as not to destroy its life, and whose young, generation after generation, vivisect their hosts, carefully avoiding the vital parts?

I will not refer to the innuendoes of Miss Cobbe about "the chamber sports of so many men of science," further than to say that, as far as my experience goes, those who study animals most closely have most sympathy with them, and that those who follow most blindly what Miss Cobbe calls "the divine impulses of compassion" are answerable for a great deal of misery they do not see and do not consider. Their sympathies follow an impulse which should be controlled by thought. If sympathy is not so controlled, there is such a tendency to sympathise with the weaker, that criminals, and those who are physically unfit for the battle of life among men and the lower animals, will come in for all the sympathy and aid that had better be given to the higher organisations, which Nature will continue to select in spite of our puny efforts to interfere with her choice. Nature's way of replying to such interference is by a slower and more lingering method of extermination, which only multiplies the pain that would have originally been given. A. J. FIELD.

ABRAHAM SHARP'S SHORTHAND.

To the Editor of KNOWLEDGE.

SIR,—I have seen, but have not had an opportunity of examining, a specimen of Sharp's shorthand. It is questionable whether the system was an original one, as it is referred to in the following terms by the editor of Dr. Byrom's system, a work on shorthand published in 1767, after Byrom's death:—

"The first occasion of turning his attention that way [referring to Byrom's study of the art of shorthand] arose from his acquaintance with the late Mr. Sharp, at Trinity College, Cambridge. This gentleman's father, at that time Archbishop of York, had recommended to his son to make himself master of shorthand as an art very useful and commodious. Incited by an authority so respectable, the two friends [Byrom and Sharp] applied themselves *to the study of the method then in vogue;* but Mr. Byrom was so disgusted with the absurdity and awkwardness of its contrivance that he soon threw it aside."

Byrom consulted everything he could procure, in print or manuscript, on the subject of shorthand, and produced a new system which soon became famous.

My object in writing is to suggest that if a number of Sharp's shorthand memoranda, which I understand are in

existence, were to be examined by some shorthand experts, they might throw a light upon the Newton-Flamsteed controversy.—Yours, &c.,

Edward Pocknell,
Past President of the Shorthand Society.
64 Imperial Buildings, Ludgate Circus,
London, E.C.

The following letter, not written for publication, will be read with interest in connection with the above and the review of Abraham Sharp's life :—

"Dear Sir,—Referring to our conversation of yesterday respecting the system of shorthand used by Abraham Sharp, I find from my notes that the 'Sharp' with whom Byrom studied an uncouth system of shorthand then in vogue was 'Tom Sharp' (as he was familiarly called), afterwards a D.D. and Archdeacon of Northumberland. This person was a son of Archbishop Sharp, and father of the well-known Granville Sharp. On Abraham Sharp's monument he is stated to be a relative of the archbishop. Both were born in the same village. Possibly one of the old books on shorthand getting into Little Horton had become known to both of the Sharp families, and, if so, the system is probably that which set Byrom's wits to work to fashion a better and more rational one.

"When Chalmers wrote his 'Biographical Dictionary' he gave an interesting account of Abraham Sharp, and stated that a chest full of letters remained in possession of his relatives—his correspondence with Flamsteed, Newton, Halley, Wallis, and other scientific men of the day—and that on the letters his answers to his friends had been carefully copied in shorthand.

"I have a specimen of Sharp's shorthand writing on a letter dated June 1705, and I have attacked the neatly written but uncanny-looking signs, with the result that in three hours last night I mastered the alphabet and most of the symbols. In time I shall penetrate the whole mystery. At all events, I can now read two-thirds of the shorthand letter and accompanying notes. The main system of shorthand used by Sharp was one of which very little is known, but it evidently contains grafts from other systems, and spurts of the writer's own fancies have made it complex. Like all these old riddles, the solution must come at last to an expert.

"Correspondence with men like Newton and Flamsteed would contain a good many scientific phrases, but that would be no bar to decipherment.

"I will endeavour to make a complete translation of the letter and notes in the course of a few days. But in the meantime you will be justified in saying 'the nut is cracked.'—Yours faithfully, John Westby-Gibson.

"February 22, 1889."

Notices of Books.

Life and Correspondence of Abraham Sharp. By William Cudworth. (Sampson Low & Co., 1889.)—The thanks of all who are interested in the history of astronomy are due to Mr. Cudworth for the publication of this handsomely printed and illustrated volume upon which he has evidently bestowed much care and the labour of many years, and in which he has collected a vast amount of matter bearing on the private life and habits of a too little known astronomer and mechanician, whose assistance contributed greatly to the success of Flamsteed's work at the Greenwich Observatory.

Abraham Sharp was born in 1653. He was the youngest but one of the ten children of John Sharp, the Parliamentarian, who fought under General Fairfax during the civil war and acted as his secretary during the western campaign. Abraham Sharp was born at a time when Oliver Cromwell was practically king of England. The town of Bradford, near to which the Sharp family had lived for generations, had sustained two sieges, and its defenders had been worsted by the Royalist forces. The town was then one of the chief centres for the manufacture of woollen cloth, and Abraham's father, John Sharp, combined the occupation of a cloth manufacturer with that of farming his own land, which lay around Little Horton. Neither of these occupations was congenial to Abraham Sharp, and on leaving Bradford Grammar School at the age of sixteen, his father apprenticed him to William Shaw, a mercer of the city of York. Mr. Cudworth gives the indenture of apprenticeship which has been preserved, from which it appears that William Shaw was to "teach his apprentice the trade or misterie of a mercer and in due manner to chastise him."

The embryo astronomer did not take kindly to his new surroundings, and long before his term of apprenticeship was out he left his York master, who was probably glad to be rid of such an uncongenial assistant, and started a school at Liverpool, where he taught writing and accounts, and tried to instruct himself in navigation and mathematics. Tradition states, that while in Liverpool he became acquainted with a merchant, in whose house in London Flamsteed was boarding. From the merchant he heard of Flamsteed's learning, and in order to be brought in contact with so gifted an astronomer, Sharp engaged himself as book-keeper to the merchant, and came to London. From Sharp's memorandum books, and Flamsteed's letters, Mr. Cudworth shows that Sharp lived with Flamsteed in 1684 and 1685, and that he became his assistant at Greenwich in 1688. In the third volume of the *Historia Cœlestis*, in speaking of the mural arc, Flamsteed says :—

> In May, 1688, J. Stafford, my amanuensis, died, and in the following August I employed in his place Abraham Sharp, a man much experienced in mechanics, and equally skilled in mathematics. He strengthened the rim with screws, carved the degrees upon it, affixed an index, and made all and each of its parts so skilfully that it was a source of admiration to every experienced workman who beheld it.

Nearly all the observations of the *Historia Cœlestis* were made with this mural arc, and from the date of its use the real work of Greenwich Observatory may be said to commence. The accuracy of its divisions, laboriously made by Abraham Sharp, and the general superiority of its workmanship enabled the first material advance on the work of Tycho Brahe to be made in determining the places of the stars and moon.

Turning to Abraham Sharp's memorandum books, which were kept with businesslike accuracy in a very neat hand, we find several interesting details with respect to this famous instrument. Under the date August 18, 1688, are the items :—

P^d ye men tht brt up the instrument . . .	£0	0	4
P^d Roger Bates for the platform and or. things for the quadrant	0	11	6
Spent on ye men that carried the quadrant up to Greenwich	0	0	6
P^d for bringing ye deals from ye yard . . .	0	0	4
Laid out for Mr. Flamsteed for lignum vitæ .	0	6	0

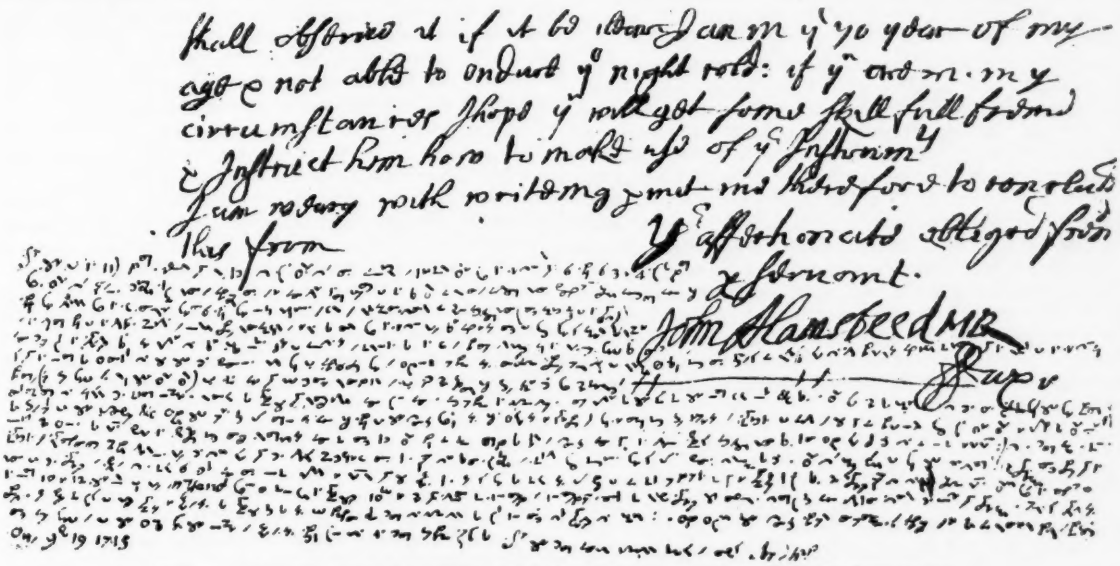
From the entries in these books Mr. Cudworth finds that Sharp was in the employment of Flamsteed at a very small stipend, which was not sufficient to maintain him. There are occasional entries of 15*l.* received from Mr. Flamsteed, with several entries of money received from "my brother and cozen." The inadequacy of his salary may no doubt be explained by the fact that Flamsteed's own stipend as Astronomer Royal was only 100*l.* a year, and for this he

was expected to undertake the instruction of two boys from Christ's Hospital in addition to his astronomical observations.

After seven years' work as assistant at Greenwich Sharp left. The reason of his going does not appear. Mr. Cudworth suggests that it was on account of his health. Flamsteed continued to correspond with his old assistant and friend during the rest of his life. Mr. Cudworth gives a long series of Flamsteed's letters with Sharp's answers; but we must confess to some disappointment at not finding more new matter. Baily and De Morgan seem already to have extracted the cream from the correspondence. On many of the letters received by Sharp and in his note-books are copious notes in shorthand, presumably the drafts of his answers. Mr. Cudworth says:—

> The system in vogue in Sharp's time (and which was then commonly acquired in order, it is said, the more readily to record the long-winded sermons of the period) is now obsolete . . . The characters are beautifully formed, as might be expected from the nicety of his caligraphy. In justice to Professor Baily's efforts, it is proper to state that we have been equally unsuccessful in deciphering Mr. Sharp's shorthand notes, and in consequence the purport of much that he wrote to his numerous correspondents is ensnrouded in obscurity.

What would that successful stockbroker and admirable astronomer, Mr. Baily, have said if he had heard himself called "Professor Baily"? We believe that he was not quite unsuccessful; at all events, his friend, Mr. Babbage, claimed to have made out the shorthand alphabet which Sharp used, and to have deciphered at least one of the letters. Some effort ought to be made to induce experts to decipher these notes. For Sharp was in correspondence with Halley as well as Flamsteed, and, if Mr. Cudworth is right, with Newton also.



End of a Letter from Flamsteed, with Specimen of Abraham Sharp's Shorthand.

Abraham Sharp's eldest brother, the Rev. Thomas Sharp, died in 1693, and Abraham shortly afterwards went to live with his sister-in-law and nephew (the widow and son of Thomas) at Little Horton, and he gave a great deal of his time to managing the family property till the death of his nephew in 1704. He was then fifty-one years of age, and wrote to Flamsteed:—

> My delay in returning answer to your two so exceedingly obliging letters had been absolutely unpardonable had not a merciful Providence pleaded my excuse, which has so troubled and perplexed me that it is with much trouble and discomposure I now write. It has pleased God to take out of this world my nearest kinsman and only nephew, a young man ever hopeful, in the flower of his age, who had a few years ago been a student of physic at Leyden. A good proficient for his time, just beginning to practise, of good parts and solid judgments. The only son of a most disconsolate mother, him on whom the hopes of a family depended which has continued here in the same name over 500 years—now likely to be extinct. The only person here with whom I could have any agreeable converse.

Abraham Sharp remained a bachelor and continued to live at Little Horton till his death at the age of ninety, in 1743. He occupied himself till the last in grinding lenses and in mathematical pursuits. His "Geometry Improved" appeared under the signature, A. S. Philomath, in 1717. Sharp calculated the "Quadrature of the Circle" to 75 places of decimals and proved the accuracy of his determination of π by a second method to 72 places. Halley, in an essay on the Quadrature of the Circle communicated to the Royal Society, wrote:—

> The problem had tempted the ready pen of the most imcomparable Mr. Sharp, who had contrived to double the famous numbers of Van Ceulen,* a degree of exactness far surpassing all belief.

The minute details given with respect to Abraham Sharp's private life are most interesting from an antiquarian point of view. It would have been well if Mr. Cudworth had induced some astronomical friend to look over his proof sheets. He would then not have spoken of Sir John Herschel as the discoverer of Uranus (p. 177), or referred to "the late Mr. G. B. Airey" (p. 319), presumably referring to Sir G. B. Airy, who is happily still alive. On p. 115 he refers to Mrs. Catherine Barton, Newton's half-niece, as the widow of Colonel Barton, who was not her husband but her brother. She was then Miss Barton and afterwards Mrs. Conduitt. Young ladies out of the nursery and schoolroom, and what would nowadays be called in Society, were in Queen Anne's days spoken of, by courtesy, as Mrs. or Mistress. On p. 76 Mr. Cudworth speaks of the "Principia" being published "through the persistence of Dr.

* A Dutch mathematician, who calculated the value of π to 35 places of decimals.

Halley, the cost being defrayed by the Royal Society." This is a mistake worth correcting, for it cannot be too widely known that Halley is the benefactor of mankind who not only urged Newton to the writing of the "Principia," but saw it through the press and paid for its publication. It was not the funds of the Royal Society which were used, though the words on the title-page, *Jussu Societatis Regiæ*, have misled many others besides Mr. Cudworth. In the case of books printed at the expense of the Royal Society it was then customary to use the words *Jussu et Sumptibus*. But the matter is conclusively proved by an entry in the Royal Society minutes for June 2, 1686, where it was ordered "that E. Halley shall undertake the business of looking after it and printing it at his own charge, which he engaged to do." This fact with respect to the printing of the "Principia" was pointed out some years ago by Professor Grant. A. C. R.

The Construction of the Wonderful Canon of Logarithms. By John Napier, Baron of Merchiston. Translated with Notes and a Catalogue of Napier's Works, by W. Rae Macdonald, F.F.A. (Blackwood & Sons, Edinburgh and London. 1889.)—Mr. W. Rae Macdonald has conferred a favour upon the student of mathematical history by publishing a translation of Napier's "Mirifici Logarithmorum Canonis Constructio," the work in which the original conception and construction of the first table of logarithms are described. The table or "Canon" itself appeared in 1614, accompanied by the "Descriptio," or explanation of its use, a translation of which, by Edward Wright, was published in 1616 (after the translator's death). But Napier's "Constructio," or account of the manner in which the "Canon" was constructed, did not appear until 1619, two years after the author's death, when it was edited by his son Robert Napier. Besides a translation of "Remarks" by Briggs, who, as is well known, devoted himself to the computation of a table of logarithms to the base 10 (the advantage of which was perceived by Napier himself), Mr. Macdonald gives some useful notes, a short biographical introduction, and a list of the various editions of Napier's works, with the names of the principal public libraries in this country, as well as of some on the Continent, which have copies. The "Constructio" is very rare, and the library of the British Museum does not appear to possess a copy. But Mr. Macdonald has overlooked that there is a copy in the library of the Royal Astronomical Society.

Planetary and Stellar Studies. By John Ellard Gore, F.R.A.S., M.R.I.A. (Roper & Drowley. 1888.)—This is really a charming little book, most beautifully got up, and, as might be expected from an astronomer of Mr. Gore's standing, all the information has been brought forward to date, while many of the papers are new or have been rewritten. The illustrations are especially good. There is much information here which could not be obtained elsewhere without ransacking scores of volumes. A sentence about "Neith," on page 31, reads rather like the riddle of the Sphinx; and we think that a reference to the "Histoire Céleste," or the seventh volume of the "Bonner Beobachtungen," might clear up some of the discrepancies in Lalande's magnitudes referred to in the chapter entitled "Some suspected variables of the Algol Type." But these are very minor matters.

Astronomy for Amateurs, edited by John Westwood Oliver. (Longmans, Green & Co. 1888).—This very interesting little volume consists of a series of papers, contributed by many well-known amateur and professional astronomers, which have been passed through the press by Mr. Oliver. A good deal of the work is not exactly new (the chapter on "Double Stars," or at least the greater portion of it, appeared in the *English Mechanic* some time before it was reprinted in the *Sidereal Messenger*), but the work, as a whole, is well done. We should specially single out for commendation Mr. Elger's article on "The Moon"; Mr. Denning's on "Comet Seeking"; Mr. Barnham's (*facile princeps* he of living double-star discoverers and observers), with Mr. Gore's additions; and Mr. Backhouse's on "The Zodiacal Light." The last five lines of page 128 read rather curiously, and is Mr. Denning certain that "the next good opportunity for studying the ring-system will occur in 1907"? H. Sadler.

A Manual of Cursive Shorthand. By Hugh L. Callendar, B.A., Fellow of Trinity College, Cambridge. (London: C. J. Clay & Sons. 1889.)—As the result of a practical acquaintance with the Pitman method of shorthand, and a series of experiments with an electric chronograph, to determine the relative time occupied in making certain shorthand signs, Mr. Callendar has declared against the geometrical school of shorthand, and has produced a system on the cursive plan, in which he embodies joined vowels and alternative devices for indicating vowel-places, three principles which are rapidly gaining favour in shorthand circles. A system constructed on such a plan is bound to be facile and legible. Mr. Callendar's forms are pretty to the eye, but his devices appear too numerous to enable us to grasp the system rapidly. A student, however, would not perhaps find any difficulty in quickly learning it. To those already practising other systems this little book will be interesting and of much value on account of the scientific and effective manner in which the author has dissected the Pitman geometrical method, and exposed its weak points. His arguments appear unanswerable.

Tables, Memoranda, and Calculated Results for Farmers, Surveyors, Land Agents, &c. (Crosby Lockwood & Son, 1889.)—Those who are interested in the management and cultivation of land will welcome this handy little volume, which is literally small enough for the waistcoat pocket. It contains practical directions for measuring land and timber, for the construction of farm buildings, with concise information as to manures, cropping, feeding, and dairy management, which is given in very clear language, and brings together the results of the most recent experiments, so as to be easily referred to. We are pleased to find a very intelligible system of farm accounts, which will be welcome to many farmers of the new order of things, who have not the same horror of putting pen to paper as some of their predecessors. The tables of weights and measures are very full, and illustrate how terribly complicated and diverse are our ways of doing business. There are no less than nine different acres given. This leads us to remark the omission of the metric system, which must sooner or later come into more extensive use in this country.

Notes.

Science is nothing more nor less than the refinement of common sense, making use of facts already known to acquire new facts.—Sir H. Davy.

In the Berlin Botanical Gardens the rare plants are photographed at the time of flowering, and prints are sent to the other botanical gardens of the empire.—*Invention.*

The foreign population of Paris is extraordinarily mixed in character. Recently foreigners were required to report themselves between October and January, and it appears (*Revue Scientifique*) that 170,262 persons of both sexes were then registered as living in the department of the Seine.

We give some of the higher figures:—Belgians, 43,712; Germans and Alsace-Lorrainers, 26,109; Swiss, 25,144; Italians, 24,178; Luxemburghers, 14,692; English, 7,688; Dutch, 3,770; Americans, 2,302.

Mr. Lant Carpenter has kindly fulfilled several of Mr. Proctor's lecture engagements, handing over the proceeds to Mr. Proctor's widow and children. At a lecture given at Crewe, Mr. Carpenter showed the action of Mr. Edison's improved phonograph. Its construction was explained by the aid of lantern photographic slides, some of which had been taken by the lecturer and some of which were lent by Colonel Gouraud. Remarkable instances were given of the perfection with which the instrument reproduced not only speech, but music and sounds of all kinds. This perfection is due to minute details of construction. The lecture was concluded with a description of the Berliner gramophone, by which the "speech records" (or phonograms) can be multiplied almost indefinitely by electrotyping, and may then be widely distributed. A pontifical blessing, for example, might be thus reproduced in various parts of the world, for the edification of the faithful, in the original papal tones of voice.

A curious treatment of rheumatism, viz. bee-stings, has been lately practised by Dr. Terc in Vienna, who describes it in a medical paper. In rheumatic patients swelling only appears after a succession of stings; continuing this unpleasant application the swelling dies down, and the patient is then cured of his rheumatism. Dr. Terc has thus treated 173 cases, making 39,000 stings with bees, of which he keeps a large supply in hives. He has special success with acute and chronic cases. Sometimes "hundreds of stings" are given; but it is right to add that the pain is much less with rheumatic than with healthy people.—From the Vienna *Medicinische Presse*.

An interesting study of the phenomena of sleep and dreams has been recently made (we learn from *Science*) by a Professor Heerwagen, of Dorpat, who sent out queries to various observers, viz. 151 students, 113 other males, and 142 females. Here are some of the results: The vividness of dreams increases very markedly with their frequency. Frequent dreams are a concomitant of light sleep, but not universally. Women have a very much lighter sleep than men, and their dreams are proportionally more frequent. With growing age dreams grow less frequent, but sleep becomes lighter. The student age 20 to 25 seems to be the period of maximum dreaming. Women dream most vividly, and students more than other men. The same relation holds as to power of remembering dreams. Women who dream frequently sleep nearly an hour longer than those who seldom dream. Students sleep longer than other men. The time needed to fall asleep is about the same in all three classes: 20·8 for the men, 17·1 for students, and 21·2 for women. Eighty per cent. of students sleep uninterruptedly through the night, 70 per cent. of other men, and only 23 per cent. of women. The power of falling asleep at will is possessed by few, and is greater in youth than in age.

We learn from *Iron* that, despite the great increase which has taken place in the production of coal in late years, the number of deaths from explosions in mines in 1888 was the *lowest* recorded in any one year since 1851, when the number was first officially given. The lowest death-rate previously to 1888 was in 1884, when 65 persons were killed by mining explosions, while the highest during the last thirty-eight years was in 1866, when the lives lost in our mines through the causes named reached 650, of which upwards of 360 resulted from the explosion at the Oaks Colliery, near Barnsley. In 1888, however, the deaths from explosions only numbered some 43. This great decrease is, no doubt, due to the precautions which a scientific study of the subject has suggested.

RARE ELEMENTS IN BEETROOT SUGAR RESIDUES.

Edmund O. von Lippmann has recently made a careful analysis of the liquor obtained in the manufacture of sugar from beetroot, with a view of discovering what rare elements are absorbed by the roots. He finds that the ashes of the beetroot contain considerable quantities of the metal vanadium, and has detected manganese, caesium, and copper in traces, not only in the roots but also in the leaves and in the raw products. Rubidium also is present in the ashes of beetroot.—*Industries*.

THE FACE OF THE SKY FOR MARCH.

By HERBERT SADLER, F.R.A.S.

A FEW scattered groups and single sunspots may be perceived from time to time, but the absence of any striking phenomena of this kind is still a marked feature of the solar surface. Conveniently observable minima of Algol occur at 8h. 19m. P.M. on the evening of the 8th; at 10h. 1m. P.M. on the evening of the 28th; and at 6h. 50m. P.M. on the evening of the 30th. The variable star R Leonis (R.A. 9h. 41m. 36s. N. Decl. 11°57′) attains a maximum on the 23rd. This star is of a beautiful red colour, and has been seen as bright as the fifth magnitude at maximum, though it is usually about the sixth. It is situated a little less than half the distance between Regulus and ξ Leonis, very slightly south of the line joining them, and is in the field of view with a white 7th magnitude star, 19 Leonis, about $8\frac{1}{4}'$ south of it, R forming an isosceles triangle with two $8\frac{1}{2}$ magnitude stars close by. Mercury is a morning star throughout the month, but is not well situated for observation, as he rises in bright twilight with considerable south declination. He is at his greatest elongation west ($27\frac{1}{2}°$) on the 13th. Venus is now a resplendent object, visible to the naked eye at noonday, and casting a distinct shadow at night in the absence of the moon. She sets on the 1st nearly four and a half hours after the sun, her diameter being 27″, and her northern declination $13\frac{1}{4}°$. On the 25th she is at her greatest brightness, five times as bright as Jupiter. Venus will be seen at this elongation with unusual brightness owing to the season of the year and her northern declination, and appears as a moon just over five days old, with an apparent diameter of 37″ and a northern declination of $21\frac{1}{2}°$. She is then about forty-one millions of miles distant from us, and sets $4\frac{1}{4}$ hours after the sun. Shortly after 8 P.M. on the 9th she will be in conjunction with a star just visible to the naked eye (No. 1482 of Hora I. of Weisse's Bessel) $6\frac{1}{2}'$ south of the star, and at 6 P.M. on the evening of the 17th she will be about 15′ to the east and very slightly north of the 6th magnitude star 26 Arietis. The student should now take every opportunity of examining the disc for spots and for the remarkable "phosphorescence" of the dark side. Both phenomena have been seen with very small instruments. Mars is, for the observer's purposes, practically invisible; as though he sets 2h. 40m. after the sun on the 1st, his apparent diameter is less than 5″; and Jupiter does not rise till after 2 o'clock on the morning of the 31st. Of the minor planets Juno comes into opposition with the sun on the 20th, at a distance from the earth of 177,000,000 miles, and appears as an $8\frac{1}{2}$ magnitude star, being on the evening of the 13th 1° 51′ due north of η Virginis. The actual diameter of this pocket planet is probably only 110 miles. Pallas

appears as a dull 7½ magnitude star, having an apparent diameter of 165 miles according to the photometric observations of Argelander, Stone, and Pickering (though Lamont, from direct measurement of the apparent diameter of the disc, raised this value to 630 miles), and passes the meridian at 5h. 24m. P.M. on the evening of the 17th. On the evening of the 19th she is 1° 40′ due north of Rigel, and on the evenings of the 28th and 29th, she is extremely close to the 5th magnitude star *v* (Upsilon) Orionis. Saturn is very favourably situated for observation, rising on the 1st at 2h. 54m. P.M., and just before 1h. P.M. at the end of the month. He describes a short retrograde path through a barren portion of Cancer. On the evenings of the 4th, 5th, and 6th, the satellites Titan and Iapetus will both be near the planet; Titan being to the north, and Iapetus to the south. The latter satellite will not be visible in small telescopes after the middle of the month until April, as he is at his eastern elongation on the 27th, about which time he is almost as faint as the faintest satellites. Uranus describes a very short retrograde path in Virgo, being 2° 55′ due north of Spica on the evening of the 9th. On the 1st he rises at 9h. 16m. P.M., and on the 31st at 7h. 12m. P.M. Neptune is in Taurus, describing a very short arc between the Pleiades and Hyades, but he does not approach any conspicuous star. There are no marked meteor showers in March. The Zodiacal Light may be looked for on moonless nights, after the last traces of twilight have disappeared, in the form of a faint spindle-shaped or lenticular cone of light extending from that part of the heavens where the sun has set to about 46° or 50° in length, and forming an angle of about 60° with the horizon. The brightness of Venus at the present time will, however, probably render the phenomenon difficult of observation for the ordinary observer. The moon is new at 10h. 1m. P.M. on the 1st, enters her first quarter at 5h. 59m. P.M. on the 9th, is full at 11h. 47m. on the morning of the 17th, enters her last quarter at 6h. 54m. A.M. on the 24th, and is new again at 11h. 37m. on the morning of the 31st. On the 9th there will be a near approach of the 6½ magnitude star B.A.C. 1651 at 5h. 34m. P.M., at an angle of 4° from the vertex, and an occultation of B.A.C. 1733, 6½ magnitude, at 36 minutes after midnight, at an angle of 156° from the vertex, the star reappearing at 1h. 28m. on the morning of the 10th, at an angle of 283° from the vertex. At 2h. 30m. on the morning of the 16th the 5th magnitude star *l* (53) Leonis will disappear at an angle of 40° from the vertex, and will reappear at 3h. 4m., at an angle of 341°. On the 22nd B.A.C. 5408, 6½ magnitude, will disappear at 2h. 32m. A.M., at 50° from the vertex, and reappear at 3h. 45m., at an angle of 248°, while at 3h. 19m. on the morning of the 26th the 6th magnitude star 4 Capricorni will disappear at an angle of 25° (the moon and star not having risen at Greenwich at the time), and will reappear at 4h. 15m. the same morning, at an angle of 272°.

Our Whist Column.

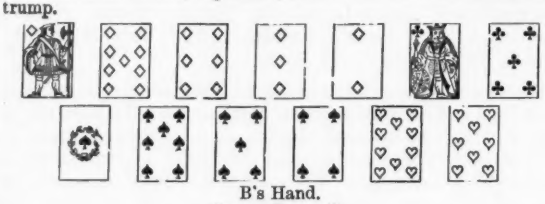
BY W. MONTAGU GATTIE.

ANSWERS TO CORRESPONDENTS.

G. WILLINS.—You should have scored 7 points—i.e., 2 for the double, 3 for the treble, and 2 for the rubber.

HAND NO. 2.

THE following hand, which is taken from actual play, affords a simple illustration of the importance of retaining a card of partner's suit until the right moment arrives for putting him in. It is frequently, as in the present instance, good policy for an opponent to defeat these tactics, if possible, even at the sacrifice of the best trump.



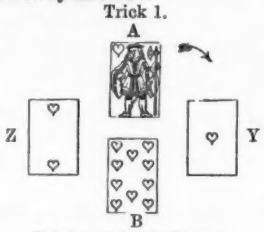
B's Hand.

Score—Love all.

Z turns up the 7 of Diamonds.

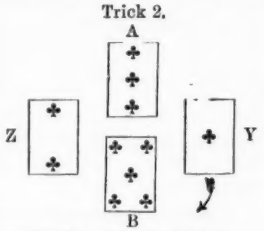
NOTE.—A and B are partners against Y and Z. A has the first lead; Z is the dealer. The card of the leader to each trick is indicated by an arrow.

Trick 1.



Tricks—A B, 0; Y Z, 1.

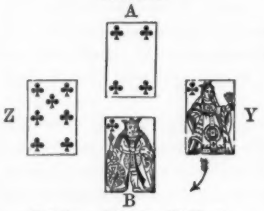
Trick 2.



Tricks—A B, 0; Y Z, 2.

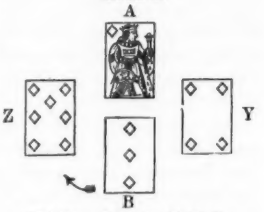
NOTE.—*Trick* 1. A's lead is almost certainly from king, queen, knave, and at least two others, in which case he has already the command of the heart suit. Having five trumps to an honour, and some protection in spades and clubs, B is fairly justified in commencing a call for trumps.

Trick 3.



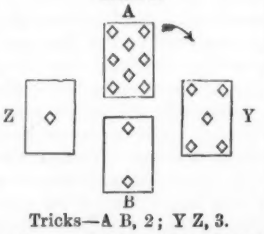
Tricks—A B, 1; Y Z, 2.

Trick 4.



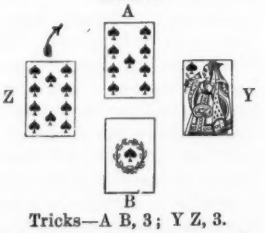
Tricks—A B, 2; Y Z, 2.

Trick 5.



Tricks—A B, 2; Y Z, 3.

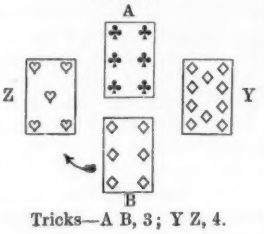
Trick 6.



Tricks—A B, 3; Y Z, 3.

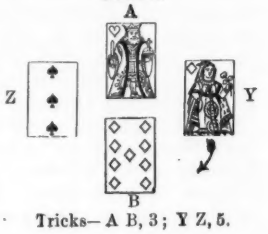
NOTE.—*Trick* 5. After this trick it is clear to B that the remaining trumps (Qn 10) are with Y; for Z's smallest was the 7 (Trick 4), and he has now had to win the 8 with Ace; and A has shown by his play to Trick 4 that he has not the queen, and by his lead at Trick 5 that he has not the 10. *Trick* 6. Z has evidently (to B) led from Kg, Kn, 10, and others; for if either A or Y had held the knave he would have played it; and, since Z must therefore have the knave, he of course has the king also.

Trick 7.



Tricks—A B, 3; Y Z, 4.

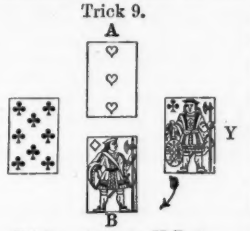
Trick 8.



Tricks—A B, 3; Y Z, 5.

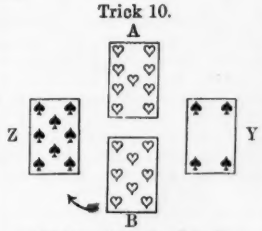
NOTE.—*Trick* 7. Here lies the point of the hand. Having only one heart, B determines to sacrifice a trick in trumps by leading up to Y's tenace, in the hope that Y will draw another trump with his queen and then continue the clubs. If B returns the heart lead immediately, Y Z make the odd trick.

Trick 9.



Tricks—A B, 4; Y Z, 5.

Trick 10.



Tricks—A B, 5; Y Z, 5.

Tricks 11 to 13. A makes the remaining hearts, and A B SCORE TWO BY CARDS.

A's Hand.	B's Hand.	Y's Hand.	Z's Hand.
D.—K, 8	D.—Kn,9,6,3,2	D.—Q, 10, 5, 4	D.—A, 7
C.—6, 4, 3	C.—K, 5	C.—A, Q, Kn, 9	C.—10, 8, 7, 2
H.—K, Q, Kn, 9, 7, 6, 3	H.—10, 8	H.—A, 4	H.—5, 2
S.—9	S.—A, 7, 5, 4	S.—Q, 6, 2	S.—K,Kn,10,8,3

Remarks.—Y plays his adversaries' game to perfection. In his anxiety to draw a losing trump, he fails to see the necessity for retaining his queen to block the heart suit. He might have foiled B entirely, and secured the odd trick, by continuing the club suit at Trick 8; for B, after ruffing, would have had no choice but to lead hearts. Y might also have made two by cards by returning the spade suit at Trick 9, but he could not be certain that his partner held the king and knave, which might have been with A and B respectively. Z's lead at Trick 6 may have been forced, for (owing to B's finesse) he could not tell that the knave, 10, of trumps were not with A, and would therefore hesitate to return the club suit, in which either A or B must be void.

ELEMENTARY EXPLANATION OF THE PLAY.

Trick 1.—A opens his long suit, and leads one of his head sequence in order to draw the ace, and so obtain command of the suit. As he has more than four hearts he leads the knave; with four only he would lead the king. Y, as second player, plays correctly in putting his ace on knave led. B commences to call for trumps by playing the ten of hearts instead of the eight.

Tricks 2 *and* 3.—Y in turn opens his strong suit. This is the orthodox lead from ace, queen, knave; the king comes out in the second round, and Y remains with the command.

Trick 4.—B leads his "penultimate" trump (the lowest but one) to show that he has five. He infers from this trick that the ace of trumps is with Z.

Trick 5.—A of course returns trumps, and B finesses the eight. A little reflection will show that, as the ace is on his left, he can lose nothing by this course; while, on the other hand, he may be a gainer if, as turns out to be the case, the ten is on his right. B infers from this trick, as already explained, that the remaining trumps are in Y's hand.

Trick 6.—Z opens his strong suit, and, holding king, knave, ten, he rightly leads the ten. The suit is cleared in one round, and B is able to infer that Z has the command; but A and Y cannot at present be certain that Z has not led the highest of a three-card suit. From A's point of view, B may hold the knave and Y the king, and Y cannot tell that B has not the knave and A the king.

Trick 7.—B knows that Y has tenace over him in trumps (i.e. best and third best against second and fourth best), and by leading up to this tenace he loses a trick in trumps; but, if he returns the hearts immediately, they will probably be trumped very soon, and he will never be able to put his partner in again. Therefore he runs a small risk in the hope of getting out the adverse trumps before giving his partner the heart.

Trick 8.—Y plays the "book" game in drawing a losing trump. His error in the present instance has already been explained. A discards his best heart to show his partner that he has absolute command of the suit. This is often a very useful hint, and may always be adopted if there is no danger of its being mistaken for a call for trumps.

Knowledge is not like food, destroyed by use, but rather augmented and perfected.—SIR JOHN HERSCHEL.

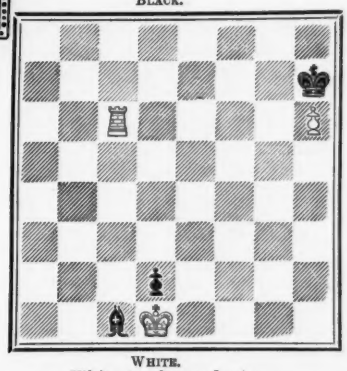
Our Chess Column.

BY I. GUNSBERG (MEPHISTO).

[Contributions of general interest to chess players are invited. Mr. Gunsberg will be pleased to give his opinion on any matter submitted for his decision.]

WE much regret that the End-game given in our February number was defective, owing to the Rook being misplaced on QR6 instead of QB6. We now give the corrected position, together with the solution.

BLACK.



WHITE.

White to play and win.

The win is brought about by White so playing his Rook that the black Bishop cannot be brought into play to attack the white Pawn, and the manner in which the white Rook limits the action of the B is instructive; the idea has been embodied in many problems. But, if the black King moves instead of the B, White plays his R on the 7th file, and also plays P to R7, compelling K to Rsq, when Black will be compelled to play his B. Then a rapid advance of the white King, although it does not prevent Black winning the white Pawn, will, however, bring about one of the positions in which the Rook wins against the Bishop. White begins with

1. R to R6

To prevent B to R6, as he threatens then to play B to Bsq; and even if White prevents this, Black has gained sufficient time to draw. B to Kt2 is, however, no good now, as White just gains the one move necessary to win, i.e., 1. R to R6, B to Kt2; 2. K × P, B to K4; 3. K to K3, B to Kt7; 4. R to B6, B to R6; 5. K to B4, B to Bsq; 6. K to Kt5, and should win.

	1. K to Ktsq
2. R to R7	2. K to Rsq

The white King must never move as long as the white Pawn is on R6, for then Black would always Queen his Pawn and get the white Pawn. It would also be wrong to play 3. P to R7 now, for Black would play B to Kt7, followed by B to Kt2, and gain the Pawn. White now plays

3. R to Q7

Because B to R6 and B to Bsq need not be feared now, as White would pin the B on Bsq by R to Q8; nor can Black play his B anywhere else from R6 with advantage, for after K × P White will, as on the preceding move, reach his Pawn in time or give it up, and win, as the following interesting variation will show:—3. R to Q7, B to Kt2; 4. K × P, B to B3; 5. K to Q3, B to Kt4; 6. P to R7, B to R6; 7. K to K4, B to Kt2; 8. K to B5, K × P; 9. K to Kt5, K moves; 10. K to Kt6, and wins. This is the main idea, and its success depends on gaining one move, which enables the King to come up just in time to bring about the winning position. But if instead of this Black plays

	3. K to Ktsq
4. P to R7 (ch)	4. K to Rsq
5. R to Kt7	

To prevent the B playing to Kt7 and Kt2 too early,

	5. B to R6
6. K × P	6. B to Q3

If 6. B to Bsq instead, then 7. R to Kt8 wins; or if 6. B to Q2, then 7. R to Kt8 (ch), K × P. 8. R to Kt7 wins.

7. K to K3	7. B to K4
8. K to K4	8. B to Kt2
9. K to B5	9. K × P

And, again, White has arrived at the same position as given in our note to White's third move, and wins by

10. K to Kt6 followed by 11. R to Kt8.

XUM

END-GAME No. 2 (FEBRUARY).

Position White. P on KKt2; K on KKt3; Q on KKt4; Kt on KKt5; B on KKt6.

Black. K on KKtsq.

White to play, and mate in seven moves with the Pawn.

Alex. Main, Middlesbrough, sends the following solution:—

1. Kt to K6, K to Rsq; 2. B to B7, K to R2; 3. Q to Kt8 (ch), K to R3; 4. B to R5, K × B; 5. K to R3, K to R3; 6. Q to Kt7 (ch), K to R4; 7. P to Kt mate.

A. C. W. has found another solution in 1. Q to Q7, K moves: 2. B to B7, K to Kt2; 3. Q to Q8, K to R3; 4. K to R3, K to Kt2; 5. B to R5, K to R3; 6. Q to B6 (ch), K × B; 7. P to Kt4 mate.

THE MAGIC SQUARE KNIGHT'S TOUR.

In view of the great interest that is manifested in the subject of magic squares, we present a perfect magic square Knight's tour.

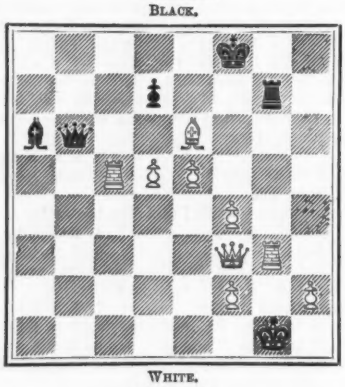
260	260	260	260	260	260	260	260	= 2080
1	30	47	52	5	28	43	54	= 260
48	51	2	29	44	53	6	27	= 260
31	46	49	4	25	8	55	42	= 260
50	3	32	45	56	41	26	7	= 260
33	62	15	20	9	24	39	58	= 260
16	19	34	61	40	57	10	23	= 260
63	14	17	36	21	12	59	38	= 260
18	35	64	13	60	37	22	11	= 260

This square illustrates the Knight's tour over the chess-board, in which the Knight plays to every square on the board, and touches it but once. Every line of figures running up and down sums up 260. Every line of figures running right and left sums up 260. Divide the board into four quarters; then the rows and files of each quarter will sum up 130. Divide the board into sixteen equal parts; the numbers that compose each sixteenth part will sum up 130. It also follows that any sixteenth portion of the board, added to any other sixteenth portion, will sum up 260. It also follows that any half row or file, added to any other half row or file in the entire square, will sum up 260. Take the files of numbers running up and down; the four central numbers of the file will sum up 130; and so of course the four remaining or outer numbers will sum up 130. These are only some of the wonderful properties of this mysterious square. This is really a *magic square*; and in comparison the ordinary square by this name sinks into insignificance.

The following ending occurred in a game played recently at Simpson's, in which an amateur received the large odds of Knight and move. His play on this occasion, though unsound, seems like the dawn of awakening genius, which will no doubt soon place him in an exalted position, far and above the odds received in the game. But, by showing the danger he ran, we hope to put our readers on their guard against attempting unsound moves, in spite of their occasional success.

MASTER.

BLACK.



WHITE.

AMATEUR.

White played

1. K to Kt2

Played with audacious intent, to deceive an old hand, as will be seen from the sequel. However ingenious, it was not the strongest move, which was 1. Q to R3, which would win easily.

1. Q to Kt8

Black rushes into the trap so skilfully prepared, as the odds giver must in a position like this seize chances, however slight they may be, that the weaker player may not see the dangers of his position. In reality, however, Black had no very good move; for, if 1. Q × R, then White would reply with 2. R × R, which the black King could not retake, as White could force a mate by Q to Kt4 (ch), &c. P × B likewise leaves Black with a hopeless game.

White now plays the trump card of his unsound though ingenious conception, which was

2. Q to K2

We do not know whether this move was accompanied by an appropriate ejaculation and accompanying jerk of the hand, as if desirous of withdrawing the move; any way, it had the desired effect, for Black too rashly, but not too wisely, played 2. B × Q, whereupon White mated in two moves, by R to B8 (ch), K to K2, R × R mate. But if, instead of 2. B × Q at once, Black would have looked ere he leaped, and played 2. R × R (ch) first, to be followed by B × Q, then in all probability White's ingenuity would have resulted in he himself losing the game. We therefore say it was very nice, but don't do it again.

HAMPDEN.—Received with thanks, and utilised above.

"THE OWL."—We hope Tyro will benefit by the lesson.

W. T. LOW.—Your communication is very interesting; we will endeavour to act upon what you say. With reference to adopting two openings principally, one for attack and for defence, it must undoubtedly be admitted that this would lead to artificial protection, as the player would at least be certain of not falling a prey to unknown variations; but from a superior point of view it is very undesirable, as in the long run the practice of playing but two openings would stunt the imagination, prevent the development of self-reliance, and thus, and also in other ways, weaken the play as against the player, who by running all risks of playing an open game, even incurring immediate losses to a considerable extent, would nevertheless thereby develop his powers of resource, his confidence in himself, and the fertility of his imagination. In a word, this is merely a principle applicable to a vast amount of subjects, and much ignored at the present time—to wit, artificial *versus* natural selection.

J. HUNTER, SOUTHPORT.—Try Mortimer's "Pocket Handbook on the Openings," published by Wyman & Sons, a most useful little work, the price of which is but one shilling, which is arranged in the tabular form of the synopsis, and contains the leading variations in each opening, to a sufficient extent to inform, but not sufficient to perplex. It is very neatly got up, and the best thing that has been published lately.

GEO. COLEY.—Solution correct. Your wish shall be complied with in due course.

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